Biodiversity Protection in Colombia: An Economic Perspective

GROW Colombia Project Report 2

Socio-Economics of Biodiversity Programme

September 2020

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Authors
Silvia Ferrini
Kerry Turner
Jaime Erazo
Corrado Di Maria
Valeria M. Toledo-Gallegos
Natalia Valderrama
Sylvia Schlesinger
Federica Di Palma – Principal Investigator

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For further information, please contact:
GROW Colombia Project
Phone: +49 (0) 1603 450001
Email: www.grow-colombia@earlham.ac.uk
Website: www.growcolombia.org

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Content

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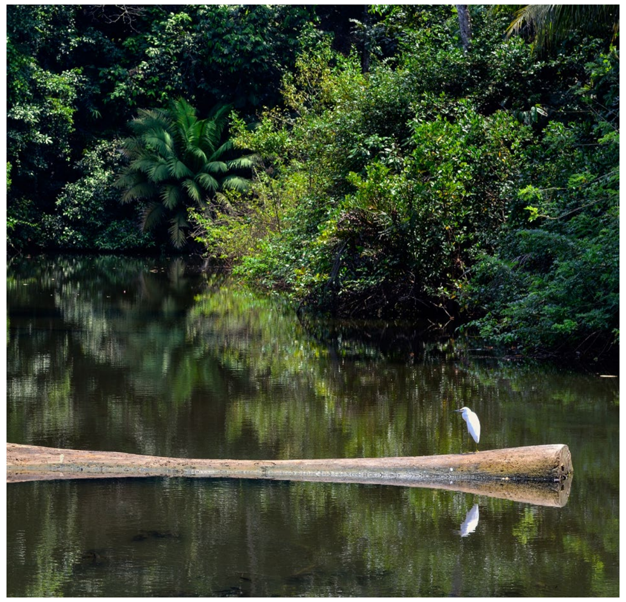
April 2020

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Executive Summary

GROW Colombia is a four year bioscience research and capacity building project to preserve, restore and manage biodiversity through responsible innovation in Colombia. This multidisciplinary initiative is funded by the UK Government's Global Challenge Research Fund and involves a wide, international collaboration of academic and civil society partners united in a shared vision to conserve biodiversity, achieve sustainable prosperity and secure lasting peace in Colombia. The project has a strong socio-economic component involving the Earlham Institute, University of Sydney, Humboldt Institute, Natural History Museum, Universidad de Los Andes and led by the University of East Anglia.

This report is the second in a series from GROW Colombia's socio-economic team. Building on the environmental change scoping analysis in Report 1 (Turner et al 2020), this second report focuses on the possible policy response to the challenges and opportunities faced by countries like Colombia in the 21st century. The corona virus pandemic, in particular, will have widescale and profound consequences for both national economies and societies as well as the global economy. So future economic and wellbeing recovery and progress will be even more dependent on carefully selected public sector investments within a reduced overall budgetary spend. While spending will necessarily be focused on short term needs in the immediate aftermath of the pandemic, medium to longer term green investment requirements should not be 'crowded out' altogether.

The development strategy and implementation measures (green investments) we advocate are guided by a vision of the future economy based on sustainability principles, a so-called 'Circular Economy' with low carbon characteristics. The basic aim of this approach is to minimise, as far as is feasible, the throughput of matter and energy in the economy (i.e the amounts of raw materials and energy we use to produce and consume all the items that support our livelihoods and lifestyles).

One of the core features of this type of economic system, in the Colombian context, is the prioritisation of biodiversity, both its conservation and management i.e. the creation of a bio-economy. Given the country's natural endowment, biodiversity is a strategic natural capital asset which can power a future, more sustainable development pathway. The bio-economy strategy seeks to protect both natural capital and ecosystem services, which in turn provide the stock of wealth and flows of wellbeing benefits vital for future human livelihoods and prosperity.
To implement a transition towards green development objectives, a macro (i.e. whole economy) economic policy, based on green investments, is proposed. The green investments (projects, policies and courses of action) can provide an economic multiplier effect, which will help create new business and employment opportunities.

The Colombian Government aims to generate 10% of its national income (GDP) from the bio-economy by 2030. However, contemporary, conventional economic appraisal of investment options is based on a monetary valuation of the costs and benefits related to any given investment opportunity. There is a danger that, for example, projects which generate a diverse range of costs and benefits, some of which lack monetary price values, do not fit easily into the current appraisal procedure. These opportunities may therefore be given less weight by policymakers and not get the prioritisation and investment that they deserve.

It is the case that valuing nature is a multidimensional concept and the assigned values are plural i.e. nature in all its aspects means different things to different people and communities. So, while we recognise that not all aspects of nature can be assigned monetary values we argue that as many as possible should be valued in this way to avoid zero value status.

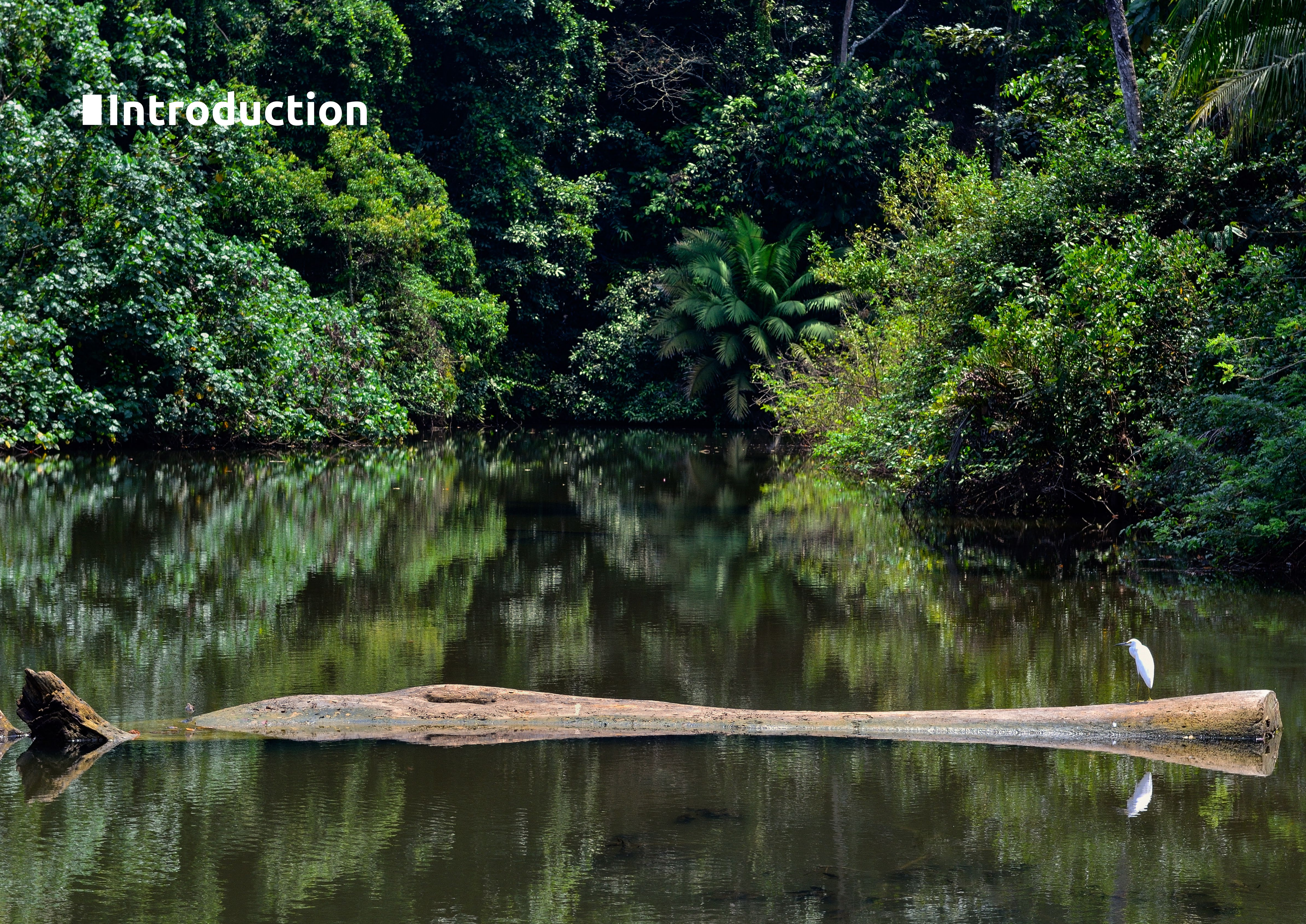
Policymaking inevitably involves choices and trade-offs. Green investments will have to compete against other options as well as each other for a share of a finite overall financial budget. To assist the policy /choice process, analysts have devised a number of so-called decision-support systems to provide an evidence base for decisions.

The GROW project supports the 'Balance Sheet approach' for decision support. This is both a process and a set of tools which can encompass multi-disciplinary data across a range of spatial dimensions and plural assessment criteria, including distributional equity as well as conventional economic efficiency. The tool box therefore includes both monetary and non-monetary valuation methods and techniques.

The more detailed analysis of a potential policy switch to foster the bio-economy in Colombia will be focused on three broad policy areas:

1. An examination of ecotourism opportunities, both from the market demand (national and international) side and the supply side;
2. An expanded production of cacao for high quality chocolate feasibility study, to include an assessment of the national and international potential market demand and farmer production opportunities and constraints;
3. An examination of cattle ranching activities and the impacts on biodiversity, with a particular emphasis on deforestation impacts; and the benefits/costs related to a switch to cattle regimes within a silvo-pastoral setting.

Introduction



Introduction

Global biodiversity represents a vast store of wealth that provides humanity with multiple ecosystem services[1] and welfare/ wellbeing benefits, including most significantly a life support system. Colombia is the second most biodiverse country on earth and therefore has a significant natural capital stock on which to draw for its current and future development. In Report 1 (Turner et al., 2019) the GROW Colombia team summarised via the DPSI(W)R framework (Figure 1), the range of environmental change drivers and pressures that Colombia is experiencing.

In this second report we focus on the policy response component of the DPSI(W)R scoping framework. We focus on selective development projects in order to highlight the way in which ecosystem services can play an important role in fostering more sustainable development in the future. We see this development path as an evolutionary transition and not a sharp macro-policy switch, although we recognise that the current environmental challenges faced by all countries, including Colombia, demand urgent action.

A contemporary problem we face in this context is the feasibility of a future in which governments wish to continue to promote economic growth while also conserving biodiversity stocks e.g. forests, wetlands, coastal and marine and other habitats. The question becomes must we abandon growth as a prime policy objective? At the macroeconomic level, in the GROW Colombia project we argue that a 'Sustainable Growth' strategy based on ecological macroeconomics offers a way forward in which green investments enabled through a mix of government expenditure, financial regulations and monetary policy, can help to promote a transition to a more sustainable (bio-economic) low carbon economy. While many formidable technical, socio-economic, socio-cultural and governance challenges will have to be faced, turning production and consumption into a more circular process is feasible. It will involve,

1) Ecosystem services are the benefits provided by ecosystems to human welfare and wellbeing. Examples of ecosystem services include food and water provision, regulation of floods and soil erosion, nutrient cycling and waste remediation. Ecosystem services also include non-material benefits such as recreational and spiritual benefits in natural areas. Ecosystem services can be grouped in provisioning (the products obtained from ecosystems e.g. food, raw material, fresh water), regulating (the benefits obtained from the regulation of natural processes e.g. climate regulation, pollination, natural hazard regulation), supporting (those supporting the provision of other services e.g. nutrient cycling, soil formation), and cultural (the non-material benefits obtained from ecosystems e.g. recreation and tourism, spiritual enrichment, aesthetic experience).

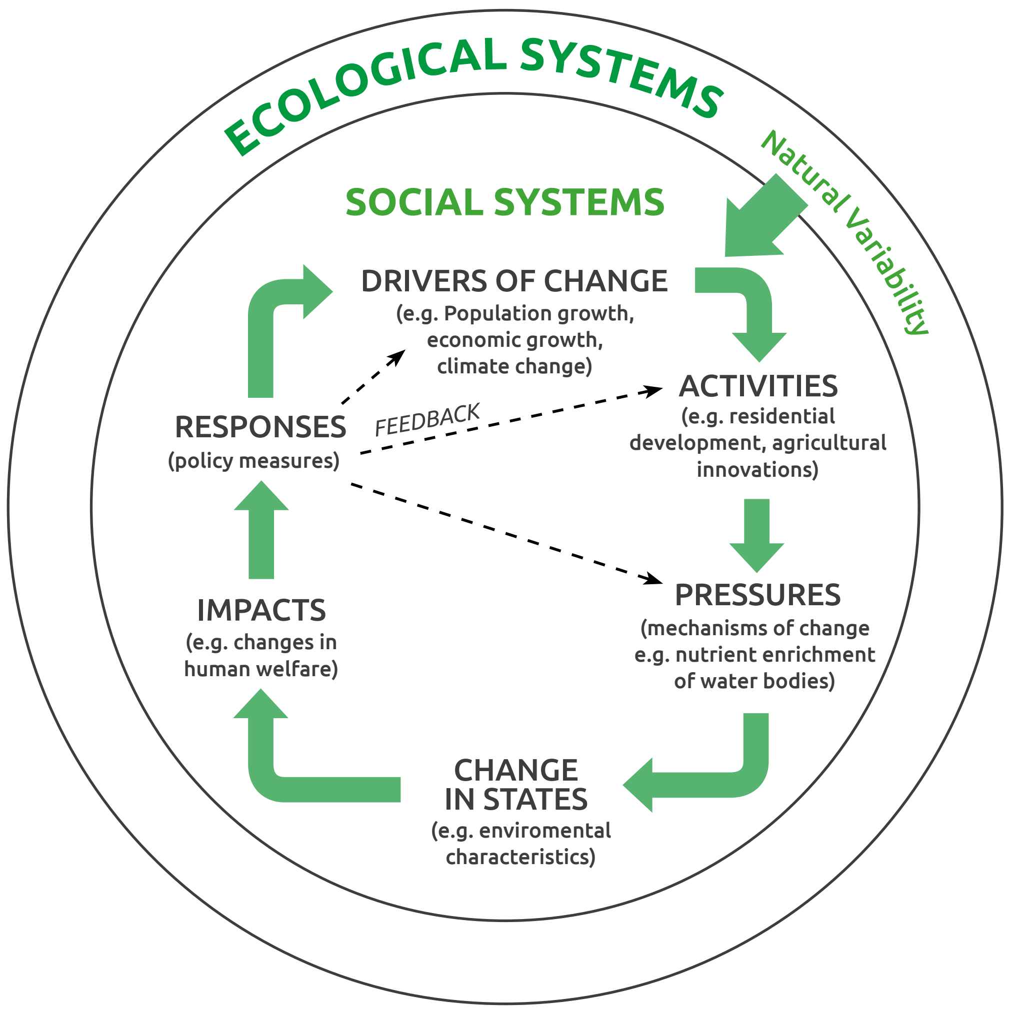


Figure 1. *Natural and ecological boundaries and the extended DPSRI framework*

among many things, encouraging reuse, recycling and product/ packaging innovations, together with a precautionary approach to overall environmental limits such as climate change, water and air pollution and natural resource over-extraction. Social limits must also be recognised in that any growth benefits must not contribute to increasing degrees of inequality, but rather benefits need to be distributed across the diverse mix of communities and ethnic groups. Important advances have been made in recent years in terms of governance for sustainability.

Governance

The Colombian Government aims to generate 10% of the national GDP from the bio-economy by 2030 and will use some of its petroleum royalties devoted to science and technology (1 billion USD in 2019/20) to assist this transformation. In December 2019, the 2015 Joint Declaration of Intent (JDI) between the UK, Norwegian, German and Colombian Governments was reaffirmed. The new 2019 document sets out the partner countries' commitments on climate change and the reduction of greenhouse gas emissions (GHG) from deforestation and degradation, while fostering sustainable development. The JDI recognises that Colombia has made significant reductions in GHG emissions from reduced deforestation in the Amazon, for which it has received 80 million EUR from the European partners. Colombia aims to reduce its GHG emissions by 20% by 2030, and its carbon tax raised 226 million USD in 2017/18.

The JDI highlights the jointly shared view that biodiversity should be recognised as a strategic national asset. It sets out plans and a timetable for further reductions in the loss of natural forests and includes additional areas to qualify for the payments for ecosystem services scheme. Special emphasis will be placed on areas of high deforestation and lands located in collective territories of ethnic groups. Colombia has also signed zero deforestation agreements with beef, dairy, palm oil and cocoa supply chains. Some payment for ecosystem services are financed through 1% of national central government transfers to the regions[2]. Biodiversity offsets from mining, petroleum and infrastructure are planned (worth 150 million USD) in 2020.

Sustainability itself is a multidimensional concept but a spectrum of world views based on two polar opposites has support in the published literature.

Weak vs. strong sustainability

A long-standing debate has evolved in the literature and policy process between supporters of so-called weak and strong sustainability. Assuming sustainability (i.e. non declining overall stock of different forms of capital - human capital, physical capital, social capital and natural capital), one of the critical issues in this debate is the degree to which natural capital is substitutable for other forms of capital. The proponents of strong sustainability see some components of natural capital ('critical natural capital') as non-substitutable and as such it should be conserved and protected so that its aggregate stock is not decreasing over time. Weak sustainability accepts depletion of natural capital, as far as this decrease is offset by innovation and technical progress which increases efficiency of usage and/or the role of other types of capital. This paradigm is historically more broadly reflected in our society – e.g. in land use change, such as transforming stocks of forests to agricultural production or through use of fossil fuels to produce man made capital. In the weak sustainability viewpoint, it is the value of the capital stock that should be kept at least constant over time, as society takes advantage of substitution possibilities.

The two standpoints could be seen at the opposite sides of a spectrum of political and philosophical positions stakeholders might take to the management of the environment. What each person, company, country or organisation adopts as her/his/its worldview, is likely to define the choice of measurement system to account for sustainable growth. Further, there can be intermediate positions held within this spectrum which might be different for different aspects of natural capital. For example, for some aspects of natural capital, society/individuals can hold a strong sustainability perspective (e.g. species and habitats/ ecosystem protection; limiting global GHG emissions), but also hold a weak sustainability perspective for other aspects of natural capital (e.g. converting some components of natural capital to infrastructure allows increase in social capital in terms of better housing, schools and hospitals). Indeed, it seems important to consider carefully which components of natural capital society deems to be substitutable and which require long-term conservation.

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Valuing nature

At the microeconomic scale (i.e. individual projects, policies or courses of action) many of the ecosystem services benefits derived from biodiversity conservation are 'crowded out' as a range of policy objectives jostle and compete for politicians' attention. Economists argue that one of the reasons for this neglect of biodiversity benefits is that their value is not fully recognised and that imputing monetary values for them can raise their political visibility. Criticism of this position focuses around the problem of incommensurability and the possible "commodification" of nature, together with a need to recognise the plurality of values and ethics intertwined with nature. While not all aspects of biodiversity are amenable to monetary valuation, it is nevertheless possible to express many important ecosystem service values in monetary terms. In the GROW Colombia project, we would argue that it is necessary to value (in monetary and non-monetary terms) many of the important services of biodiversity

2) Law 99/1993 defined in article 111 that 1% of central government money transfers to regions, known as "ingresos corrientes de la nación", should be used to buy lands that protect watersheds. Law 1450/2011, related to the National Development Plan 2010-2014, modified this article to allow local and regional governments to finance Payment for Environmental Services in strategic environmental areas that provide water to municipalities and regions. Article 175 from Law 1753/2015 (National Development Plan 2014-2018) enable other funding sources like water use fees, money transfer from the electricity generation sector, 1% forced investment of total value of projects that use water, and biodiversity offsets from environmental licenses.

linked to green growth projects, to avoid zero value by default. At the same time, we support a plural view of values that opens up a number of opportunities for deliberation and negotiation in sustainability project/ policy decision making processes. We use the 'Balance Sheet Approach' as a decision support system to enable our analysis which is focused on three policy areas:

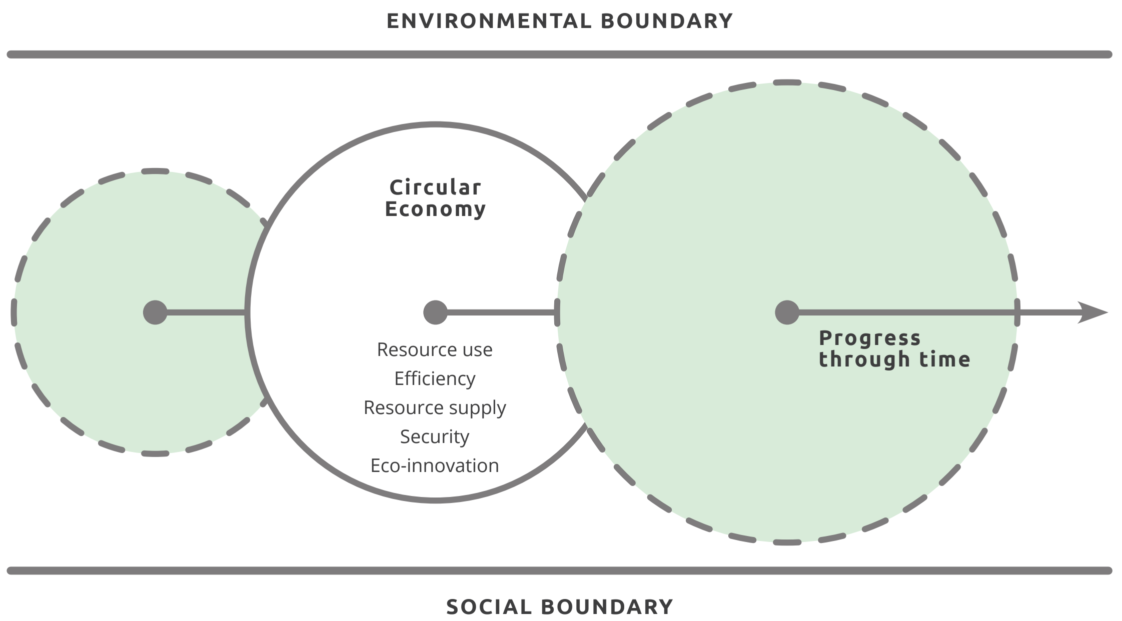
1. ranching activities and biodiversity conservation;
2. the production of cacao for high quality chocolate; and
3. ecotourism potential.

We turn first to an explanation of the macroeconomic strategy for green development linked to an expanded version of the so-called circular economy model. This is followed by a summary of our decision support system used to analyse the gains and losses from the selected green development projects at the microeconomic level.

An expanded circular economy model

We assume that the overarching policy goal in Colombia is sustainable development, enabled through a sustainability pact, "that seeks an equilibrium between production development and the environment conservation that potentiate new economies and ensures natural resources for future generations" (Departamento Nacional de Planeacion, 2019). Under such an approach contemporary society is required to pass on to future generations a total capital stock (physical, human, social and natural capital) that is as good as, or better than, that received. Our expanded Circular Economy system is constrained by two 'boundary' conditions; an outer environmental boundary and a lower 'social floor' boundary linked to maximum acceptable level of wealth inequality, and minimum acceptable level of deprivation (Figure 2)[3].

Figure 2.
An expanded Circular Economy constrained by boundary conditions



The Circular Economy sits between these boundaries in a space that is 'safe' and 'fair'. These boundaries serve to warn society about any economic growth that risks breaching thresholds or tipping points that may produce sudden and/or irreversible environmental state changes and damage costs, which combine to threaten national and eventually global systems resilience. The social inequality boundary also has an economic dimension. There is a strong case to argue that gross inequality carries both an economic and a social price and that these are interwoven. Growing inequality is associated with growing inefficiencies and less productive economies which also display increased stress, poor health, and low levels of social mobility. The Expanded Circular Economy approach allows for a broader vision of economic progress, which produces sustainable economic development and increases in societal well-being. Our Expanded Circular Economy paradigm is more comprehensive than some previous applications of this concept. Investments in green projects eventually leading to system-wide innovation will be necessary, and the transition needs to be underpinned by systematic assessment of environmental and social consequences of economic changes. At the sector and/ or individual project level we deploy a pluralistic approach to appraisal which extends beyond the conventional economic cost-benefit approach.

Plural values in nature

The economic valuation of natural capital and ecosystem services in monetary terms has been criticised on two main grounds: the problem of incommensurability and the "commodification" of nature; and the neglect of value plurality. The standpoint taken in this report is that while the "commodification" of nature is something to be wary of, i.e., not all aspects of nature are amenable to monetary valuation, it is nevertheless possible to express many important ecosystem service values in monetary terms. Further, we would argue that it is necessary to do so to avoid these important services being assigned zero value by default in policy appraisals. Value plurality opens up a number of opportunities for deliberation and negotiation processes with their related methods for eliciting relative values. It also can help to highlight contestable contexts in which disputes over rights and ethics are important (Fisher et al., 2008).

3) The Circular Economy is expanded to include plural values in nature as well as equal and fair distribution of benefits across current and future generations. Therefore over time the economic growth is bounded by social and environmental limits.

A plural view of values reflects the multiple ways in which people are connected to nature. Figure 3 illustrates four quadrants that summarize the major conceptions of value.

The left-hand side includes instrumental values, which relate to the use of nature in order to improve human wellbeing and nature functioning; on the other side intrinsic values reflect the value that nature and its components have in and of themselves (see Box 1).

This categorisation of nature's value has been criticised in terms of its abstraction and lack of a more general appeal to policymakers and the public (Kenter, 2018). Some analysts portray our relationship with the environment as simply gaining a living from the environment; living in the environmental space; and living with an environment with other non-human interests which we nevertheless recognise and take into our consideration (O'Neil et al., 2008). Chan et al. (2016) have proposed that "relational values" might offer a simplified extension to how to think about environment-related values.

There is a danger that too many definitions and terms add little to our understanding of the role and value of natural capital and ecosystem services and so we argue the categorisation in Box 1 is a sufficient basis to distinguish between the different plural values in nature that are relevant for policy. The way in which the values are broadly measured reflect the distinction between economic, biophysical and socio-cultural values. Economic and biophysical values are frequently measured as quantities expressed in different units e.g. £ of food sold, tonnes of CO_2 stored, and socio-cultural values in qualitative terms (e.g. narratives, expert judgements and others).

Environmental economists have promoted the harmonization of quantitative measurements into a common unit money, but challenges and limits still exist. Social media and big data are opening doors to new innovative approaches to the understanding of the relationship between quantitative and qualitative measures and people and the environment. For example, van Zanten et al. (2016) use social media platforms (e.g. Flickr, Instagram) focusing on publishing photos online to identify valuable landscape features across Europe. Further, work related to the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES) has developed a novel framework to extend the ecosystem services approach

A plural view of values reflects the multiple ways in which people are connected to nature.

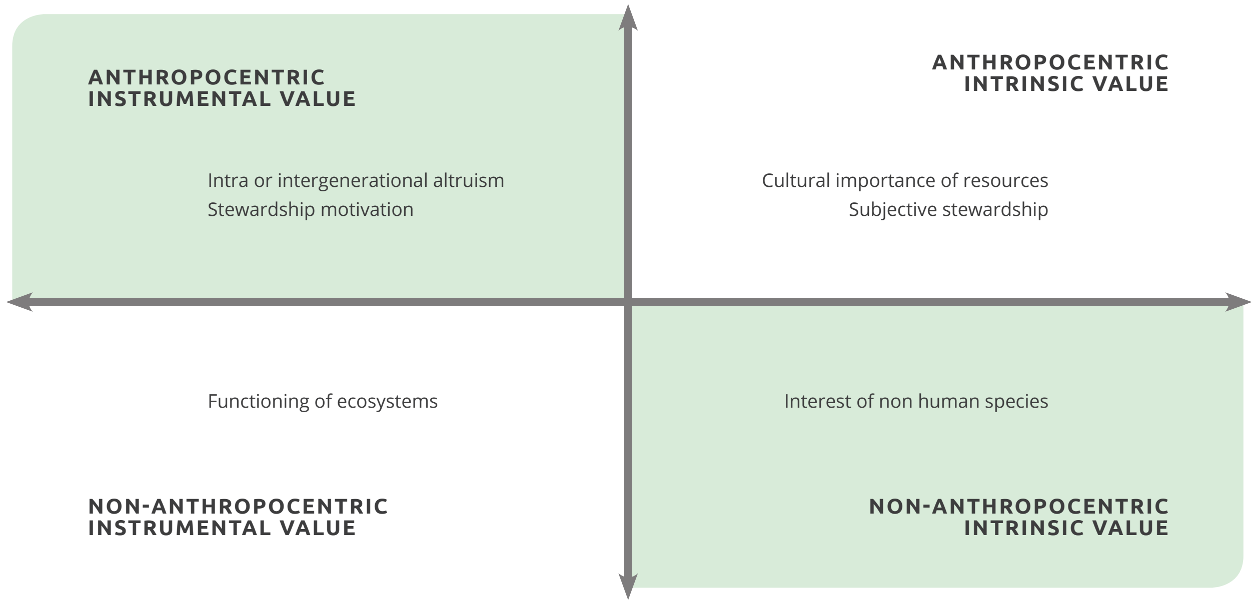


Figure 3. *The Major conceptions of Value*

Box 1: Major conceptions of Value

Anthropocentric Instrumental Value

This is equivalent to 'total economic value' = use + non-use value. The non-use category is bounded by the existence value concept, which has itself been the subject of much debate. Existence value may therefore encompass some or all of the following motivations:

- Intra-generational altruism: resource conservation to ensure availability for others; vicarious use value linked to self-interested altruism and the 'warm glow' effect of purchased moral satisfaction;
- Intergenerational altruism (bequest motivation and value): resource conservation to ensure availability for future generations;
- Stewardship motivation: human responsibilities for resource conservation on behalf of all nature; this motivation may be based on the belief that non-human resources have rights and/or interests and as far as possible should be left undisturbed.

If Existence value is defined to include stewardship then it will overlap with the next value category outlined below.

Anthropocentric Intrinsic Value

This value category is linked to stewardship in a subjectivist sense of the term 'value'. It is culturally dependent. The value attribution is to entities which have a 'sake' or 'goods of their own', and instrumentally use other parts of nature for their own intrinsic ends. It remains an anthropocentrically related concept because it is still a human valuer that is ascribing intrinsic value to non-human nature.

Non-Anthropocentric Instrumental Value

In this value category entities are assumed to have sakes or goods of their own independent of human interests. It also encompasses the good of collective entities, e.g. ecosystems, in a way that is not irreducible to that of its members. But this category may not demand 'moral considerability' as far as humans are concerned.

Non-Anthropocentric Intrinsic Value

This value category is viewed in an objective value sense, i.e. 'inherent worth' in nature, the value that an object possesses independently of the valuation of valuers. It is meta-ethical claim, and usually involves the search for strong rules or trump cards with which to constrain anthropocentric instrumental values and policy.

Source:
Turner, R. (1999) The place of economic values in environmental valuation. In Valuing Environmental Preferences (Bateman, I. and Willis, K., eds), pp. 17–41, Oxford University; adapted from Hargrove (1992)

- Nature's Contributions to People (Diaz et al., 2018) – which aims to allow for a pluralistic valuation approach to ecosystem assessment.[4] How this framework can be operationalised is yet to be fully demonstrated, and the substitution of the term ecosystem services by nature's contribution to people does little to add clarity to the debate (Kenter, 2018).

Ecological economists have also long been concerned with the connections between the value elicitation methods deployed and the underlying values themselves. It has been argued that the elicitation process itself may define the values being uncovered and so methods such as cost benefit analysis and others are themselves value articulating institutions – i.e., these processes and methods play a key role in forming the value itself (Vatn, 2005; Marshall et al., 2011). The elicitation process may be not just uncovering existing values but helping to form values through a sort of social learning process (Vatn and Bromley, 1994).

The key message we take from this debate is that decision support processes and tools should be able to encompass a range of value dimensions and should recognise that many are irreducible and not amenable to simple aggregation into a composite score. This is particularly the case if sustainability policy objectives are seen as key goals.

To sum up, the complex problems related to natural capital and ecosystems management and policy making increasingly require decision support systems that can encompass income and possibly wealth inequality issues, together with plurality, i.e. a wider diversity of consequences (benefits and costs) and a range of stakeholders' perspectives. To chart a course through the different concepts and worldviews that surround the management of nature, we propose to start with the conventional approach to the construction of an evidence base for policy appraisal and then incrementally add to the underlying evidence base as we recognise other decision criteria. This includes distributional equity and inequality concerns in addition to the conventional economic efficiency rule; and different conceptions of nature's value together with their underlying ethics and their inclusion in the evidence base for policy making. In the next section we describe a process for incorporating these various dimensions of environmental values into policy making process, a Balance Sheet Approach.

4) IPBES aims to reflect the different knowledge systems that exist around the globe by employing a generic perspective (seeking "a universally applicable set of categories of flows from nature to people", p. 271) that is typical for western sciences and a context-specific perspective (that "typically does not explicitly seek to extend or validate itself beyond specific geographical and cultural contexts", p.272) which is often associated with local and indigenous knowledge (ibid).

The Balance Sheet Approach: decision support system

Decision support systems should aim to provide as comprehensive an evidence as possible. Such systems need to include data collection, scoping and agenda setting frameworks, data modelling and interpretation as well as the monitoring of policy outcomes. The Balance Sheet Approach (BSA) (Turner, 2016) can represent one such decision support system for environmental policy formation and evaluation. The distinct features of the BSA are firstly, its focus on fairness and equity concerns and distribution of these across space and social groups, while also explicitly considering compensation mechanisms between the major stakeholders that are impacted by a given policy. In conventional economics analysis a solution is deemed feasible when it passes a hypothetical compensation test, i.e. gainers from a policy change must gain enough to hypothetically compensate all losers from the change and still remain better off. In political economy terms, however, hypothetical compensation is unlikely to find much in the way of general societal support. Therefore, the BSA extends this analysis with an added emphasis on actual compensation, equity, fairness and inequality, i.e. who gains and who loses.

The second distinct feature of the BSA is that it also provides a framework for the incorporation of different valuation concepts and methods into sequential stages of the decision-making process and their application domains.

In the BSA three complementary and interlinked stages of analyses – or three overlapping balance sheets – are followed which progressively focus on the increased complexity of environmental decisions and contested contexts that might arise in policy implementation (see Figures 4 & 5). Each stage provides complementary components that offer comparable sets of findings with overlaps and linkages (Turner, 2016).

Decision support processes and tools should be able to encompass a range of value dimensions.

The three stages provide further evidence and detailed understanding of the spatial distribution of impacts and the groups these impacts concern. As degree of complexity and degree of controversy increases, the need for a range of value concepts and valuation methods increases. This range includes increased use of non-monetary deliberative methods both for assessment and (potential) conflict resolution. The overall

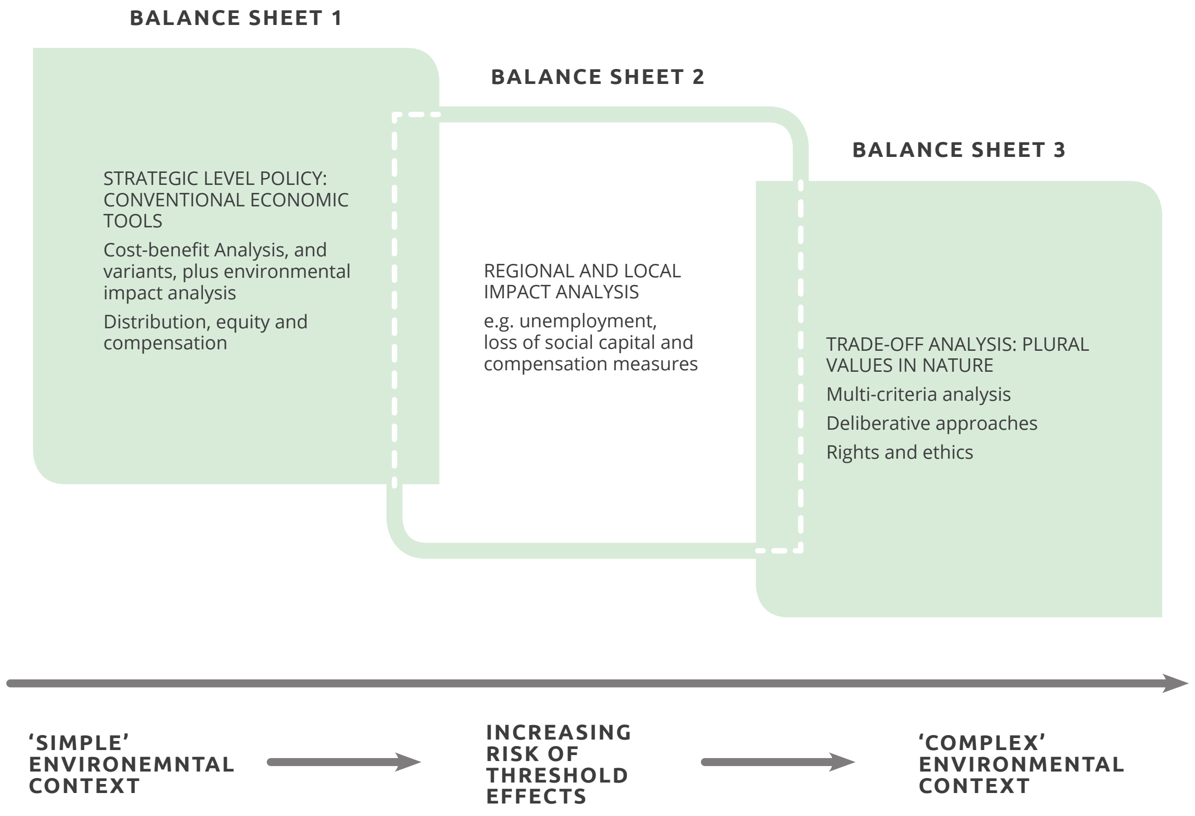


Figure 4.
The Balance Sheet framework

objective is to allocate resources across projects, policies or courses of action that maximise the use of scare resources and reduce the social conflicts that might hamper implementation of the concerned policy solution.

For ease of exposition the BSA is set out below in sequential fashion, but the process and related tools involved can be utilised in a piecemeal way, e.g. it may be that a project at the regional scale is under analysis and policymakers just want an indication of who gains and losses in that localised context and so the focus can be directed straight to balance sheet 2. So flexibility is a key characteristic of the BSA.

The three Balance Sheets

The analyses in the first balance sheet first considers and focuses on the (macro) economic efficiency criterion at the given decision level, which favours the policy alternative that in total generates the highest net benefits over all stakeholders. But it then extends this analysis into distributional questions and the need for and practicality of actual compensation (Turner, 2007). This is the transition phase into the next balance sheet. Balance sheets 2 and 3 provide a more nuanced understanding of policy implications with added focus on spatial and socio-economic analysis of the different stakeholders that are impacted by the decision at issue and on policy implementation.

In the second sheet, regional and local impact analysis focuses on the spatial disaggregation of the evidence gathered in the first "balance sheet", including regional natural capital assets, and the implied distribution and socio-economic characteristics of the winners and losers at the sub-national scale. The focus here shifts to regional and local policy implications and/or their evaluations in the context of major policy indicators such as income/wealth distribution,

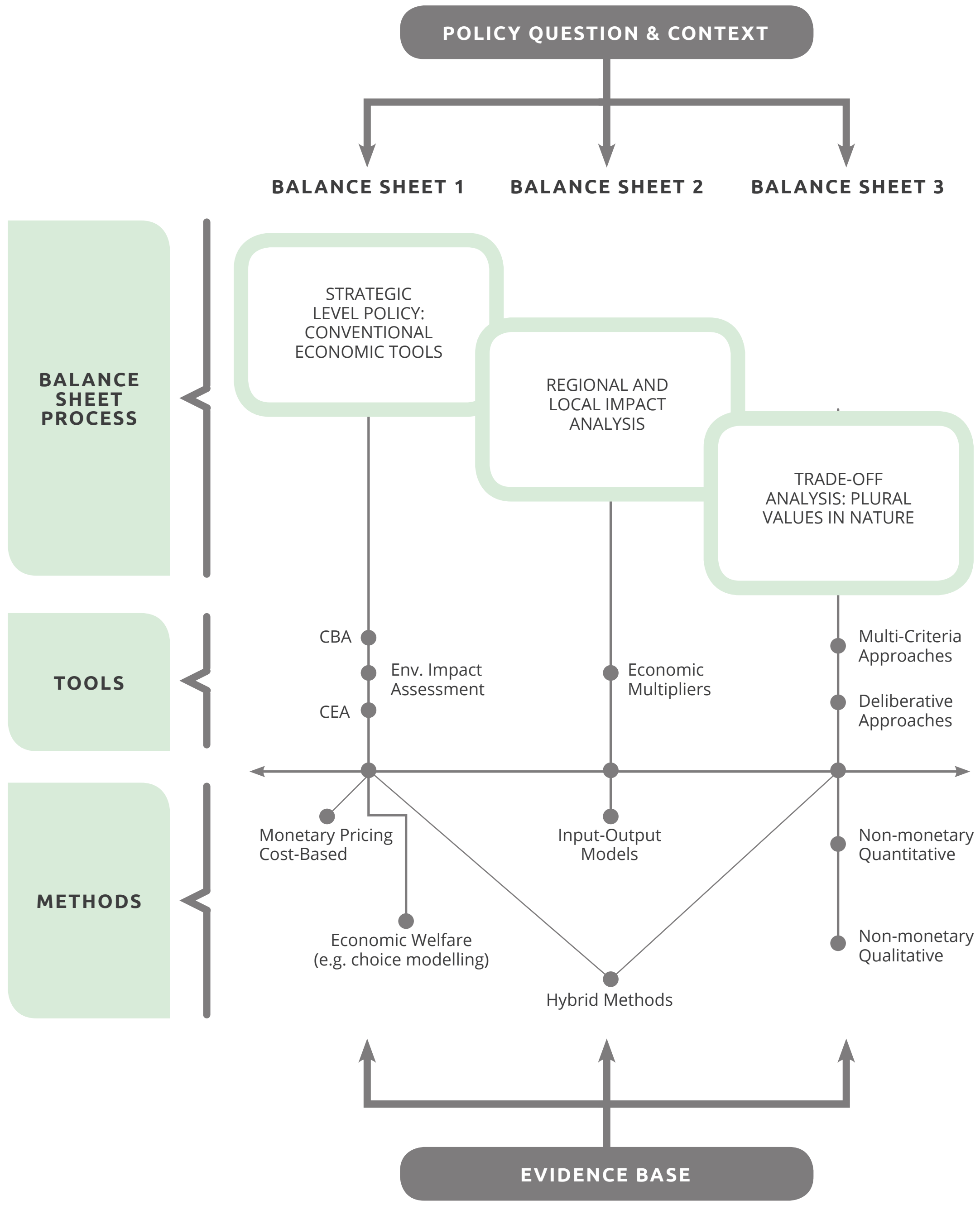


Figure 5.
Policy Questions and Context flow diagram: the Balance Sheet Approach

structural unemployment, but also issues related to loss of community identity, natural capital and cultural assets.

At this regional scale, tools such as economic multipliers and input-output models can play a useful role. Further, an explicit discussion of the potential compensation mechanisms between the winners and losers is required for the next balance sheet. In this stage of BSA, social network analysis (and similar tools), may be used to identify the major stakeholders in the decision context which can then be built on in the next stage of the BSA. Indeed, it is likely that this analysis might reveal a number of contested areas and potential conflicts between stakeholder groups that the planned policy change might create.

In the third balance sheet, a trade-off analysis aims to support negotiation over contested issues between stakeholders. Crucially, this phase of BSA focuses on implementation of feasible policy solutions that accommodates the views of contesting stakeholders through specific compensation measures[5] that can be in different forms, including in kind, e.g. biodiversity offsets; or through substitution between natural capital loss and social capital gains (Lazaro-Touza and Atkinson, 2013; Turner, 2007) or financial compensation such as the payments for ecosystem services scheme. This requires detailed understanding of the relevant stakeholders, their views, motivations and beliefs and therefore the wider range of values that might be at stake. In this third stage, a different so-called social welfare function can be relevant which prioritises equity concerns. If strong, sustainable development is the over-arching policy goal then 'other regarding' preferences in society can be accepted. This translates into the assumption that individuals care not only about themselves and their consumption of goods and services, but also the relative position of other people in their community, country, or globally. If people have 'other regarding' preferences and related ethics, then inequality and the value of the environment and its conservation will be a more prominent problem requiring solutions. This information can help to identify and, if possible, find procedural solutions to contested issues of the policy change.

Inequality, distribution and the environment

BSA's distinct feature is its aim to incorporate inequality and distribution concerns within the decision-making process. We therefore discuss in this subsection why these considerations are important in environmental management.

5) This is in contrast to the Strategic level view Sheet that focuses on application of potential economic Pareto efficiency, which considers only hypothetical consideration of compensation.

As income/wealth increases an individual's valuation of public environmental goods and welfare gain increases but at a diminishing rate. So the preferences of wealthier people have a greater weight/impact on social decision making. Richer people will give up more of their income than poorer people for a given (equally desirable) environmental improvement and so have an undue influence on policy changes. The overall distribution of income in a society, i.e. how equal or unequal it is, will influence the value put on environmental public goods and who gains most from the resulting benefits. In a number of contexts, if a society is experiencing less income inequality over time the value that it assigns to environmental public goods benefits will increase (and vice versa). As inequality decreases a disproportionate share of the non-market environmental benefits flows to poorer households. One way to adjust Cost Benefit Analysis (CBA) for this distributional issue is to deploy distributional weights to the cost and benefit calculations, i.e. to weight more highly, for example, the costs and benefits accruing to poorer households in an increasingly unequal society. This is rarely done in current cost benefit appraisals, with the exception of climate change analysis. More recently an aggregate willingness to pay inequality adjustment approach has been suggested, which it is argued requires less information (Drupp et al., 2018).

There is also another aspect of inequality relevant for environmental valuation and policy, which is that there is evidence to suggest that the costs of environmental degradation and loss fall disproportionately on the poor (Sirinivasan et al., 2008; Turner and Fisher., 2008). Care should therefore be taken to consider the overall net distributional effect, including both market and non-market benefits and costs. Inequality in society encompasses not just income but also wealth. The latter includes stocks of natural capital and the benefits that flow from them in terms of ecosystem services. So the spatial distribution of natural capital assets, e.g. forests, other culturally important landscapes etc. is important, together with access provisions.

We now turn to selected green investment projects which could play a part in Colombia's development strategy. The report is focusing on the three following policy switches:

- from traditional tourism to eco-tourism
- to sustainable cacao production
- from traditional agriculture to more sustainable systems (e.g. silvo-pastoral system).

Sustainable tourism

Photo: Alexander Velasquez-Valencia

1 Sustainable tourism

Tourism in Latin America is still in a development stage as many economic and social factors are delaying the growth of this sector.6 The annual growth rate over the last two decades in Latin America was on average 3.4 %, a slow pace compared to the global rate of 4.0 % (de Oliveira Santos, 2015). However, Latin American countries are rich in natural resources and attractions and the tourism sector is forecasted to grow rapidly by 2030. The tourism sector in Colombia grew faster (10%) than in the rest of Latin America in the period 2001 and 2011 (PROEXPORT, 2012; Zuñiga-Collazos and Alexander, 2015). In 2000, the Ministry of Commerce, Industry and Tourism of Colombia (MCIT, 2010) reported 557,280 international tourists and in 2014 roughly 2,288 million[7]. This suggests that foreign visitors almost quadrupled in 15 years and the tourism contribution to GDP is expected to be 6% by 2027 (WTTC, 2017).

Despite the enormous natural and cultural wealth of Colombia, the tourism sector was hampered by Colombia's civil war which lasted more than 50 years (Kokalj, 2007). The confrontation of the state army with rebel groups and drug trafficking has affected the perceived image of Colombia abroad and discouraged visitors from travelling. While the war had detrimental economic and social effects it also protected the rural territories from mass tourism exploitation.

6) Such as "economic and financial instability, structural unemployment, inflationary pressure, income inequality, uncontrolled urbanization, lack of public safety, health problems and political uncertainty (de Oliveira Santos, 2015)."

7) The Ministry of Commerce, Industry and Tourism of Colombia is developing a new methodology to estimate the number of international tourists. For 2014 total international tourist were estimated in 2,865 million, and for 2018 a total of 4,276 million were reported (MCIT, 2019). In 5 years international tourists grew 1,5 times.

The peace agreement, signed in 2016, represents an opportunity to develop tourism activities in remote rural areas where preserved forests offer high concentrations of endemic and threatened fauna (Baptiste et al., 2017). Therefore, sustainable tourism is considered to be a strategic source for recovery in Colombia, after the signature of the Peace Process Agreements in 2016, that is also compatible with the economic development of rural communities8 and the conservation of the country's Natural Capital. Colombia has a significant diversity of ecosystems and species.

The country is ranked first for the number of birds and orchid species; second in richness of plants, amphibians, butterflies and freshwater fish; third for number of palms and reptiles; and the fourth in mammals diversity (IAvH, 2017). On the other side, it has five ecosystems which are considered emblematic: páramos, high altitude wetlands, tropical savannas, tropical dry forest, and cloud forest. The presence of wild and charismatic species (Naidoo and Adamowicz, 2005; Okello and Yerian, 2009) and aesthetical landscapes (Di Minin et al., 2013; Hausmann et al., 2017) represent positive signals that can motivate visits to protected areas (Hausmann et al., 2017; Okello and Yerian, 2009).

Domestic tourism is expected to play a major role in Latin American countries (de Oliveira Santos, 2015) but also with international tourism, including ecotourism, demand is steadily increasing which can promote Colombia's popularity. At the same time, the delay in developing mass tourism activities represents a privileged position for Colombia, which has the opportunity to develop a sustainable tourism sector which encompasses economic growth, social inclusion and biodiversity protection. In 2018, the Colombian Government produced the Voluntary National Review for the Sustainable Development Goals and committed to developing tourist opportunities within sustainable boundaries using innovative financial mechanisms to boost and promote the sector.9

Tourism can play a major role in achieving several different

8) In 2012, the Ministry of Commerce, Industry and Tourism of Colombia defined policy guidelines to develop communitarian tourism in Colombia. Since then the Ministry has recognized the importance of the tourist demand reactivation in the country, the need to strength the social function of tourism, the importance of this sector to promote local development and conservation, and the active participation of local communities within the tourism sector. It is acknowledge that the communitarian tourism must contribute to enhance communities living conditions, based on a differential ethnic and socioeconomic approach, that allow the establishment of development strategies, for overcoming poverty and to achieve the Millenium Development Goals (MCIT, 2012a).

9)Bancóldex in Colombia has announced an energy efficiency credit line for hotels that will be refinanced with a green bond emission (DNP, 2018)

Sustainable Development Goals. In particular, the sector could have a positive impact on protecting biodiversity and promote a sustainable use of terrestrial and marine ecosystems. The Colombian Voluntary National Review considers sustainable tourism as a key sector to promote economic growth and tackle climate change (Fig.6).

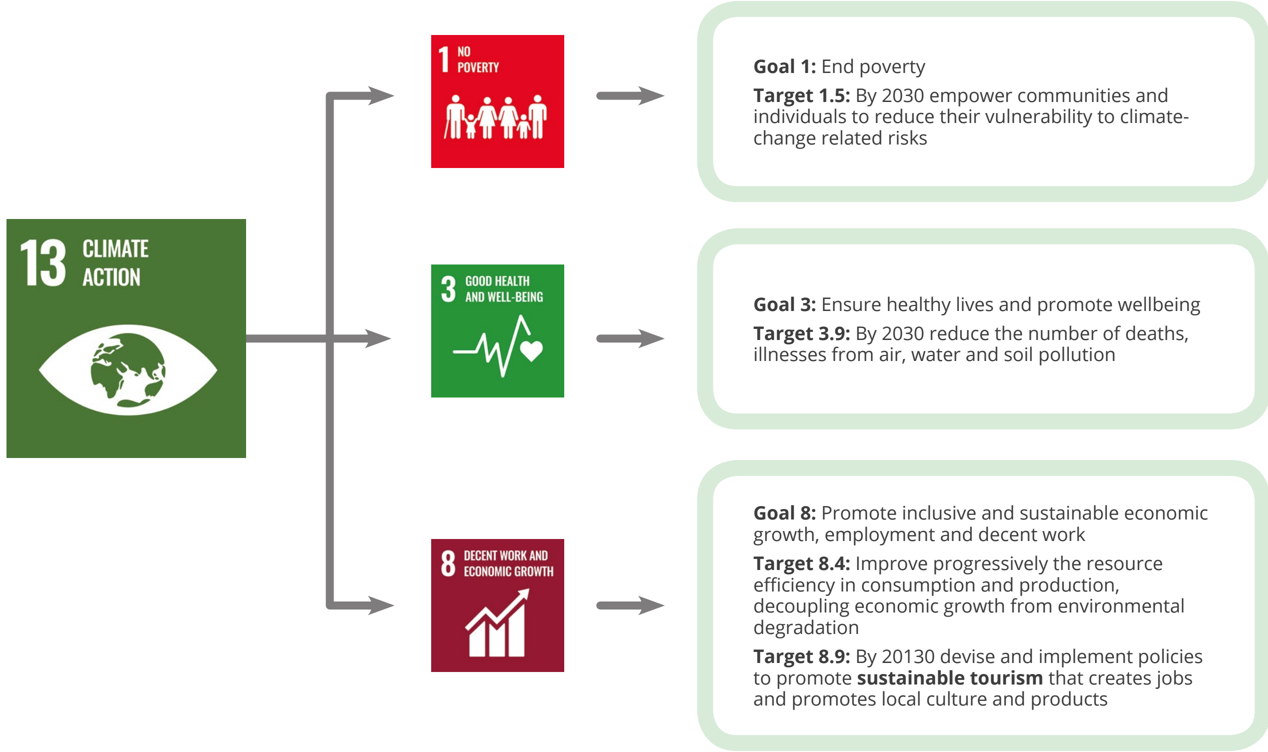
Tourism in general while contributing to economic growth has also caused a range of environmental and social problems. In the future a more sustainable form of tourism should be a key policy objective in the 21st century.

Sustainable tourism includes a wide range of tourism activities (e.g. ecotourism, nature-based tourism, scientific tourism, spiritual tourism, green tourism)10. Sustainable tourism should satisfy the expectation of visitors without damaging the natural and social capital of the destination countries. Commercial viability should be combined with economic/financial benefits to the local economies, and a respect for and understanding of the diversity of cultures (including heritage, religions and nature resources).

In Colombia, history records one of the first forms of ecotourism in 1799, when Alexander von Humboldt travelled in South America to discover "a dramatic, extraordinary nature, a spectacle capable of overwhelming human knowledge and understanding. Not a nature that sits and waits

10) Stronza et al (2019) report a detailed classification of green tourism.

Figure 6.
The Role of sustainable tourism to support Goal 13 Climate change action
Source: Adapted from Departamento Nacional de Planeación, 2019



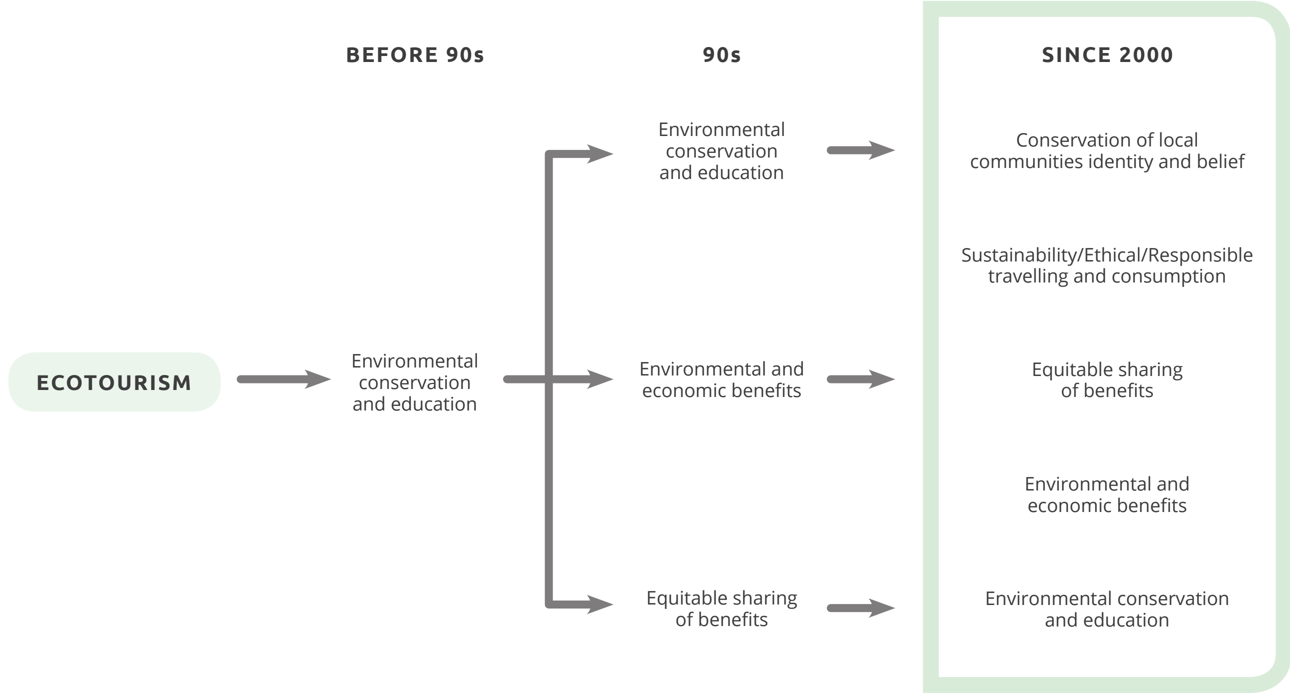


Figure 7.
The Definition of Ecotourism

to be known and possessed, but an active nature, bestowed with vital powers, many of which are invisible to human eyes; a nature that dwarfs humans, dominates their beings, awakens their passions, and challenges their powers of perception. (Pratt, 2010, pp. 229–230)." In the 18th century, von Humboldt's work provided a new vision of South America and its natural beauties in (1) an overabundance of natural forests (Amazon and Orinoco); (2) snow-capped mountains (the Andes and Mexican volcanoes); and (3) the vast central plains (Venezuela and the Argentinean pampas).

While von Humboldt was one of the first eco tourists that travelled in Colombia to learn about nature and its ecological functioning, the characterisation and formal definition of ecotourism only emerged many years later.

Ecotourism

The ecotourism definition evolved in the last two decades (Figure 7) from environmental conservation and education roots (Ceballos-Lascurain, 1991) and evolved into ethically responsible travelling which considers local and cultural diversities (Das and Chatterjee, 2015).

The key elements of ecotourism are:

- Conservation of the resources on which tourism relies
- Tourism that provides a sustainable flow of economic benefits to all relevant stakeholders (national to local).

This new form of tourism requires a different role for private and public agents and a constant engagement with stakeholders.

Photo: Alexander Velasquez-Valencia

Ecotourism must reflect the diversity of countries and should reflect local and cultural identifies. Das and Chatterjee (2015) and Stronza et al. (2019) review more than 30 years of ecotourism activities which yield mixed findings on the pros and cons of this form of tourism. "Ecotourism is both an expansion and a refinement of the connection between tourism and conservation. It builds on the idea of using tourism to reinforce conservation and vice versa, while deepening the criteria for sustainability" (Stronza et al., 2019). Ecotourism differs from nature-based and wildlife tourism as it requires learning, interpretation and conservation of nature and local communities. Wildlife tourism and ecotourism differ according to the captive/ non captive interaction of humans with wildlife and consumptive/ non-consumptive tourism (Tisdell and Wilson 2012 for a review).

Ecotourism requires the intention and determination to learn from and conserve natural and social attractions. Stronza et al. (2019) highlight that ecotourism is frequently confounded with other forms of tourism and its effectiveness in protecting the environment depends on multiple factors.

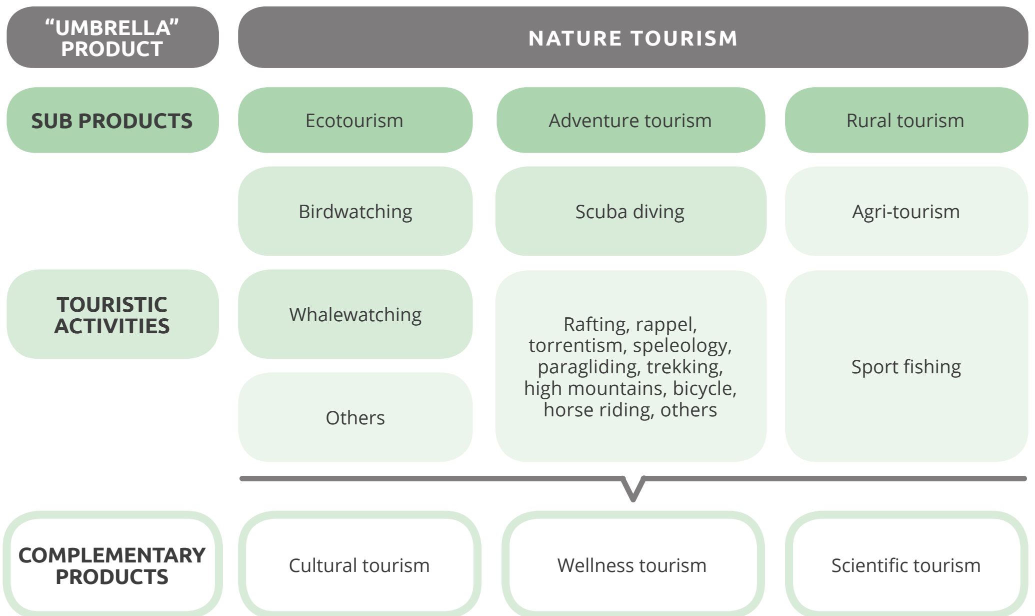
Ecotourism in Colombia

Since 2003, the Colombian Government has promoted guidelines to develop the ecotourism sector and declared an interest in developing ecotourism to generate benefits for communities and businesses, with minimal impacts on the environment and local communities (MCIT and MADS, 2003). In the same year, Resolution 531 was signed in Colombia to position ecotourism as a complementary tool for the conservation of biological diversity, and to define the policies/rules for developing ecotourism in the Protected Areas of the country. The 2004 policy document CONPES 3296, was created to establish the guidelines that regulate the private participation (concessions) in ecotourism services in natural protected areas.

In 2012, the Ministry of Commerce, Industry and Tourism of Colombia adopted a National Policy for Nature Tourism, a main or "umbrella" concept that includes ecotourism, adventure and rural tourism (or agritourism) as a number of sub categories. Among the touristic activities prioritized for ecotoursim were birdwatching, whalewatching and scuba diving (see figure 8). This policy was very comprehensive in its definition of nature tourism as "all kind of tourism, based on nature, in which the main motivation is nature observation and appreciation, as well as traditional cultures" (MCIT, 2012b). The policy also considered the human dimension of tourism when it specified that: "tourism [..] is framed within the sustainable human development parameters. Ecotourism seeks the visitors' recreation and education through the observation, the study of natural values, and the cultural aspects associated with them. Thus, ecotourism is a controlled and directed activity that produces minimal impact over the natural ecosystems, respect the cultural patrimony, educate and raise awareness on the importance of

Figure 8. *Umbrella product, sub products and priorities, for nature tourism in Colombia*

Source: adapted from MCIT, 2012b



nature conservation. Ecotourism must generate income directed to support and promote natural areas conservation, in which it is developed, and surrounding communities" (MCIT, 2012b).

In 2013, the Ministry of Commerce, Industry and Tourism of Colombia developed the business plan for nature tourism and defined priorities for touristic activities by department, for the three sub products, based on the ability of achieving a competitive advantage within three distinct time frames: immediate (im), short run (sr) and medium run (mr)[11]. The priority activities and departments were (Avia Export, Tourism Leisure & Sports, & Europraxis, 2013):

- *ecotourism:* National Parks/ buffer zone of protected areas (im; Antioquia, Valle del Cauca, Amazonas, Magdalena, Cundinamarca, Meta), birdwatching (im; Antioquia, Magdalena. Cundinamarca, Caldas, Risaralda, Quindío), pristine beaches (sr; La Guajira, Chocó, Providencia, Magdalena) and whalewatching (sr; Chocó),
- *adventure tourism:* continental waters (im; Antioquia, Amazonas, Magdalena, Cundinamarca, Meta, Santander, Boyacá, Huila, Tolima, Bolívar), scuba diving (sr; Providencia, Magdalena, San Andrés), valleys and mountains (sr; Santander, Boyacá, Magdalena), and adventure beaches (mr; Santander, Boyacá, Magdalena),
- *rural tourism:* high quality coffee growing zone (im; Caldas, Risaralda, Quindío), wellness ranch (mr; Cundinamarca, Antioquia, Caldas, Risaralda, Quindío) and ranches with traditional activities (mr; Antioquia, Casanare, Meta, Arauca).

Carvajal Valero and Gonzalez (2016) analyse the prioritized activities and sub products from the nature-based tourism business plan (ecotourism, adventure, and rural tourism or agri-tourism and identify nine Colombian departments (see Table 1) that can be prioritised for their ecotourism opportunities. These are Antioquia, Boyacá, Chocó, Cundinamarca, Magdalena, Meta, Quindío, Risaralda, San Andrés y Providencia and Valle del Cauca. The authors recognised that these regions can be easily characterised and marketed, following the example of other Spanish speaking countries (e.g., Spain).

In 2015, the National Inter-Institutional Ecotourism Committee of Colombia was created to promote, evaluate and articulate the implementation of plans, programs and projects to strengthen ecotourism.

Privilege areas for ecotourism are protected areas that in Colombia protect a significant part of the country's' biomes. However, Forero-Medina and Joppa (2010) found that 60% of these biomes have less than 10% of their area protected. The level of protection is not uniform nationally, and the Andes, the northern Orinoquia regions, the Caribbean, the Magdalena and Cauca Valleys are less well protected than the Amazon and other parts of Colombia. The National System of Natural Parks (14.268.224 hectares) protects 11.27% of the continental area and 1.5% of the marine area. Private conservation areas belong to the Civil Society Reserves Network (MCIT and MADS, 2003) and they could be also suitable for ecotourism activities.

	ECOTOURISM				ADVENTURE TOURISM				RURAL TOURISM		
DEPARTMENT	Protected Areas	Birdwatching	Whalewatching	Pristine beaches	Continental waters	Scuba diving	Valleys and Mountains	Adventure beaches	Cultural landscapes (coffee)	Haciendas (welfare)	Haciendas (traditional activities)
Antioquia	IO	IO			IO						
Boyacá	STO	STO			IO		STO				
Chocó	STO	STO	STO	STO							
Cundinamarca	IO	IO			IO						
Magdalena	IO	IO		STO	IO	SOP	STO				
Meta	IO	STO			IO						
Quindío	STO	IO							IO		
Risaralda	STO	IO							IO		
San Andrés y Providencia			IO	STO		IO					
Valle del Cauca	IO	STO			SOP						

Blue is Immediate Opportunities *Green Short-Term Opportunities*

Table 1. *Colombian departments with nature-based tourism potential (Modified from Carvajal Valero and Gonzalez, 2016)*

11) Immediate actions correspond to activities between 2012 to 2015. Short run corresponds to 2016-2018 and medium run corresponds to 2018-2021.

Other suitable areas for ecotourism activities are UNESCO sites. Between 1984 and 2019, Colombia registered nine UNESCO World Heritage sites designed for the conservation of globally significant locations. Six are cultural sites (Coffee Cultural Landscape, Historic Centre of Santa Cruz de Mompox, Port Fortresses and Group of Monuments, Andean Road System and San Agustín Archaeological Park), one site is both cultural and natural (Chiribiquete National Park) and two sites are of natural interest (Los Katios Natural Park and Malpelo Fauna and Flora Sanctuary). Tinsdell and Wilson (2012) argue that tourism increases when sites are UNESCO registered, but lack of security and illegal activates might threaten these sites (https://whc.unesco.org/en/news/1936/).

At the national level, the Coffee Region is the first rural tourism destination. According to SITUR PCC (Tourist Information System of the Coffee Cultural Landscape, 2018), the vast majority of the visitors to this region in 2018 were nationals (91.3%), followed by 1.8% travelling from the US, and 0.5% from Germany. This region comprises 25 municipalities of the central departments of Caldas, Risaralda and Quindío; and is the location for most of the national coffee production (Aranda et al., 2009).

Privilege areas for ecotourism are protected areas that in Colombia protect a significant part of the country's' biomes.

In recent years, the number of visitors to National Natural Parks has been increasing (Figure 9) with a spike in 2016 (49% annual growth rate) which is the year when the peace treaty was signed in Colombia. Despite this growing trend there is not enough evidence to claim that this is ecotourism, as it might involve activities which result in the consumption of natural resources.

Further, even if the majority of protected areas offer "ecotourism opportunities" and essential level of services (e.g. visitor centres, trails, viewpoints), the numbers of visits to the National Natural Parks are mainly driven by only two protected areas (USESPNOEE-MINCIT, 2018). According to the Colombian Ministry of Trade, Industry and Tourism, the area which received the majority of visits in 2018 was the Natural Park Corales del Rosario y San Bernardo (62% of the total visits) located in Sucre and Bolívar, which contain a vast network of coral reefs and protected ecosystems. This is followed by the National Natural Park Tayrona, which in 2018 received 25% of the total number of tourists. It comprises 15,000 ha of protected beaches and forested areas located near the city of Santa Marta in northern Colombia. The remaining natural protected areas only contributed 13% of the yearly visits to National Natural Parks.

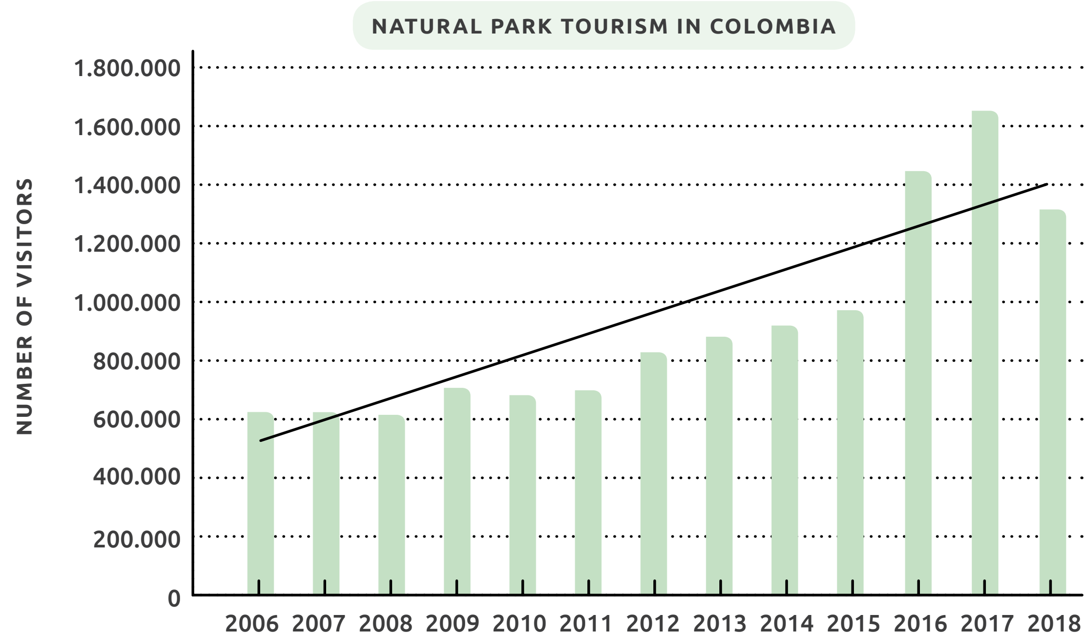


Figure 9. *Yearly visits to National Natural Parks in Colombia (USESPN-OEE-MINCIT, 2018)*

Scuba diving represents one of the key successes in the two most popular national parks, and since it generates relatively low environmental impact, it has been promoted as a sustainable tourism option that can finance marine and terrestrial biodiversity conservation programs (Roberts et al., 2017). Trujillo et al. (2017) apply the travel cost method to estimate the economic welfare provided by recreational scuba divers in the Coral Reefs in Rosario and San Bernardo National Natural Park. The scuba diving activities in this natural park generate an economic benefit of USD 157 per diver, and a total annual benefit of USD 658,359 (on the basis of 4200 annual diver visits in the area). The extrapolation of the welfare benefits to other popular diving destinations in Colombia (e.g. the Malpelo Island in the Pacific Ocean and Providencia island in the Caribbean Sea) demonstrates that scuba diving can attract significant funds to prevent the acceleration in the destruction of already degraded marine resources. The Caribbean coasts for example have experienced an 80% reduction of the coral reef cover (Doney et al., 2012).

Zuñiga-Collazos and Alexander (2015) report that the national market highly favours 'sun, sand and sea' tourism over more nature-based attractions and this can explain the reduced demand for the other national parks. Data from the Colombian Travel & Tourist Agents Association (ANATO, 2018) indicate that in 2018 approximately 14% of the travel agencies mid-year sales were for beach destinations, whereas alternative forms of tourism like cultural tourism (10.3%,), ecotourism (8%), adventure tourism (7.2%) and agri-tourism (5.4%) only capture smaller percentages of sales. Díaz et al. (2013) report that there is a low offer of ecotourism opportunities by national travel agencies. They report that 26% of travel agencies were unaware of the ecotourism destinations, and that 30% of them declared that their clients were also not aware of their existence.

The Colombian Travel & Tourist Agents Association statistics (ANATO, 2018) also reveal that 54% of travel agencies sales were to international destinations signalling that in 2017 Colombians prefer out of country tours. Similarly, the results of the survey on expenditure for domestic tourism 2014-2015 (DANE, 2016a) indicate a lack of national tourism demand with only 12.4% of residents living in the main cities travelling outside of their area in a year. There is clear evidence that national demand can represent a national driver for ecotourism activities. In order to promote the development of eco-tourism in Colombia, it is necessary to overcome some barriers. They include, the absence of an effective ecotourism policy, the inadequate design and development of ecotourism products and their promotion, the poor infrastructure (i.e. roads, public services, lodging), the lack of a national tourist culture, and the absence of ecotourism guides, information and marketing packages (MCIT and MADS, 2003; MCIT, 2012b). Further requirements for attracting international visitors are bi-lingual guides and information products.

Colombia has the potential to become the world's premier birdwatching destination.

The current sustainable tourism statistics signal the need to further develop tourism supply chain policies that:

- integrate tourism companies with national suppliers,
- avoid income leakages
- offer sufficient tourism-related infrastructures and investments
- promote training for skilled tourism workforce and administrations and
- promote effective marketing strategies.

A promising opportunity to develop ecotourism activities in Colombia is birdwatching. Colombia has the potential to become the world's premier birdwatching destination. Currently, the birdwatching activities are concentrated in the Andes and the Sierra Nevada de Santa Marta, but more recently this activity has been extended to the southwestern corner of the country, in the Putumayo department, located in the Andes–Amazon transition (Ocampo-Peñuela and Winton, 2017). Maldonado et al. (2018) report that economic benefits can flow from birdwatching tourism in regions previously inaccessible due to the armed conflict. They report that at a cost equivalent to the average WTP of Audubon12 members (USD 310 person/day) the expected annual number of bird observers would be between 10,000 and 15,000 accordingly to the models presented in the paper. Moreover, they forecast that if birdwatchers visit Colombia once during the next ten years, birdwatching tourism would generate USD 9 million in profits per year, and more than 7,500 new jobs. This study does not however report specific results for regions but just aggregated potential estimates.

Whalewatching and pink-dolphin are other opportunities for ecotourism activities. Currently, few regions (Bahía Malaga in the southern Colombian Pacific and the Amazon basin) are organized for whalewatching ecotourism (Zapetis et al., 2017). However, this ecotourism attraction has recently begun to expand to other regions in Colombia, such as the Caribbean which also provides suitable habitat for marine mega-fauna and is considered to be a migratory corridor for several species of cetaceans (Jiménez-Pinedo et al., 2011; Zapetis et al., 2017).

Curved tail of a humpback whale in Bahia Solano, Colombia

12) Audubon International Alliances Program

Given that Colombia ranks fourth in the world for the diversity of mammals, charismatic species ecotourism is another promising option for promoting biodiversity conservation of terrestrial and marine species (e.g. McClenachan et al., 2012). Primates and birds (Calle-rendón et al., 2018; Ocampo-Peñuela and Winton, 2017) have been proposed as the flagship species that could be targeted by ecotourism activities. However, the exclusive use of flagship species to attract ecotourists might produce unintended consequences like the marginalization of areas with low numbers of charismatic species (Goodwin and Leader-Williams, 2000; Krüger, 2005; Veríssimo et al., 2009) and an overall under-appreciation of biodiversity (Goodwin and Leader-Williams, 2000; Kerley et al., 2003).

Recent literature has indicated that more experienced tourists are also interested in seeing less charismatic species (Di Minin et al., 2013) however in high biodiverse countries like Colombia, it is likely that protected areas with high conservation value report a lower presence of charismatic species (Baptiste et al., 2017), and as a consequence charismatic species tourism may produce detrimental effects.

In order to develop a sustainable, effective, and equitable ecotourism industry in Colombia, it is important to systematically analyse the different environmental, economic and social conditions

View on Tuk tuk on the street in Bahia Solano, Colombia

of locations of interest. In this way ecotourism activities could attract national and international tourists and provide local welfare and environmental protection. Figure 10 conceptualises the logical framework to assess and design ecotourism opportunities.

The national political context is the key background to the analysis of ecotourism opportunities. Since 2010 the Colombia government and ProColombia, the entity responsible for Colombia's international promotion as a tourism destination, have shown interest and commitment in supporting ecotourism opportunities.

The other influential factors in a successful ecotourism supply chain are the main institutions operating in the locations of interest. These can be the local government, the private sector, local organizations and donors. Restrepo and Clave (2019) analyse the role of different tourism institutions for the development of regional tourism. They conclude that the understanding of institutional dynamics is crucial to boost management and planning for a more effective regional tourism. Further, to assess and design ecotourism opportunities it is necessary to consider jointly the supply and the demand side of ecotourism. The *supply* represents the opportunities that the different local areas can offer in term of natural capital (e.g. charismatic vs non-charismatic species), human capital (workers)

Given that Colombia ranks fourth in the world for the diversity of mammals, charismatic species ecotourism is another promising option for promoting biodiversity conservation of terrestrial and marine species

and socio-economic conditions. For example, a rural area with mainly low-income farmers will complicate the choice of where lodging and tourism facilitates can be located. While an area with existing lodging and accommodations might just need to consider whether the tourism flow will be adequate for the local accommodation capacity or how the current accommodations can respond to the eco-tourists' demand. Local stakeholders need to be involved in the designing and planning of ecotourism infrastructures to minimise the social conflict and provide a unique touristic experience to visitors. The Utria National Natural Park in the department of Chocó represents a good example of locals and tourism industry integration. Local communities who live in the Pacific coast have always protected the cultural traditions of their ancestors and are now starting to appreciate that birds and whales are providing a valuable source of wealth, and as a consequence they have stopped deforesting and are now protecting/ supplying a diverse natural capital for the tourists to enjoy.

The development of ecotourism opportunities also provides new opportunities for employment that can require training programs, experts from other areas or competition with other industries in the local job market. For example, in the Utria National Park, locals have stopped illegal hunting and they are now offering tourist guide and other touristic services. Before investing in the ecotourism opportunities is necessary to anticipate the tourist demand, impact on natural conservation programmes and socio-economic consequences. The forecasting of tourist demand is crucial for investors as well as local stakeholders to appreciate the profitability of the market. Direct market surveys and well-coordinated marketing strategies are the main instruments to determine the market demand for future ecotourism opportunities (Tinsell and Wilson, 2012).

Ecotourism activities can lead to social risk for local communities, commodification of ethnic minorities, and appropriation of intellectual property from ancestral knowledge.

For example, in 2016 the Utria National Park doubled the number of visitors due to the promotion of the site as an eco-tourism experience for bird and whalewatching. In this case, branding ecotourism initiatives (Carvajal Valero and Gonzalez, 2016) or World Heritage awards might offer comparative advantages to local communities.

Research objectives

The design of ecotourism opportunities that are fair, sustainable and profitable requires a careful assessment of the tourism supply chain and a transparent framework of analysis. Figure 10 reports the framework suggested in this project to identify and evaluate the tourism opportunities in Colombia case studies.

The construction of a framework for analysis is considered essential, as the literature shows that the overall effects of ecotourism can be either positive or negative. Caviedes Rubio and Olaya Amaya (2018) analyse the current impacts of ecotourism in Colombia and they flag up the landscape disruption due to tourism infrastructures and services. Other environmental damages are the deterioration of fragile environments (e.g. mangroves and coral reefs) as discussed by multiple authors (e.g. Ramírez et al., 2008; Doiron & Weissenberger, 2014); different types of pollution (e.g. water, visual, noise) (e.g. Lopez-Angarita, 2014); alterations to the wildlife behaviour (e.g. Bateman and Flemming, 2017); as well as the introduction of invasive species (Anderson et al., 2015). In the sociocultural context, ecotourism activities can lead to social risk for local communities or the commodification of ethnic minorities as well as the appropriation of intellectual property from ancestral knowledge (e.g. Coria and Calfucura, 2012; Maldonado et al., 2006). Finally, the economic benefits generated in the area could lead to an increase in the cost of land and the cost of living (e.g. Maldonado et al., 2006); the generation of seasonal (rather than permanent) employment; and the economic leakage that occurs when a lower per cent of the benefits (e.g. due to low wages) stay in the area (Sekercioglu, 2002).

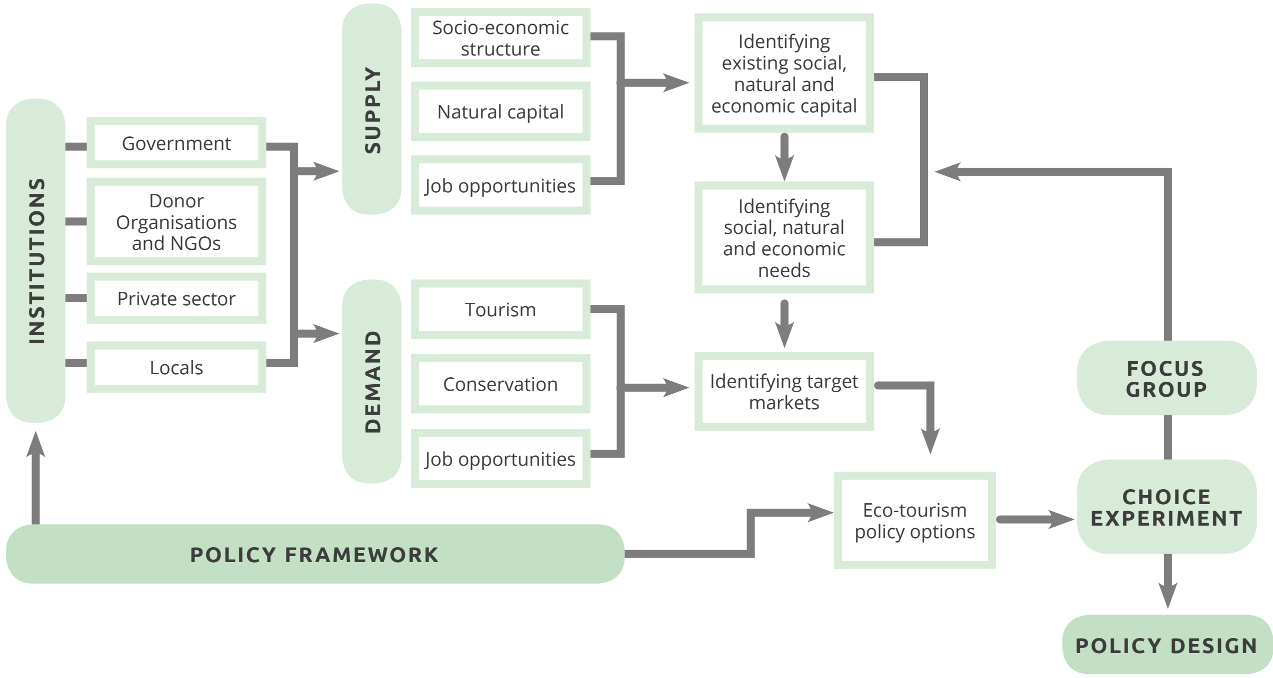


Figure 10. *Visioning and planning for ecotourism opportunities*

Figure 10 highlights the need for the engagement of local stakeholders at the beginning of the process to identify policy context, social and environmental conditions and barriers to develop ecotourism opportunities. The study of supply and demand for ecotourism activities is essential to determine the success of the development and local characteristics should be contrasted with local and international visitors' expectations. For positive long-term benefits of tourism in less developed areas, tourism development is recommended to take place slowly thus allowing the local community to learn, develop experience, capital, knowledge and know-how, to make necessary adjustments, and grow along with tourism growth.

Sustainable cacao

Photo: Neil Palmer/CIAT

2 Sustainable cacao:

Consumer demand and farmer production options

History of cacao

Cacao is an important crop for rural areas in Colombia, as it is the raw material from which chocolate is manufactured.

In the pre-Columbian era (450 BC), cacao trees were of high value, as the Aztecs believed that cacao seeds were the gift of their god of wisdom (Quetzalcoatl).[13] Seeds were used as a form of currency and drinking chocolate was a pleasure restricted to the communities' rulers. The history of Spanish explorers', as told in their reports, indicates that in 1519 Hernán Cortés observed at the court of Montezuma (ruler of Tenochtitlán) the rite of chocolate drinking and that soon after Spanish travellers started importing the cacao beans in Europe. For a couple of centuries, only European aristocrats and royals could consume chocolate.[14] In the early 18th century, innovations transformed the cacao flavour and texture and it became a cheaper product[15]. By the beginning of the last century, chocolate entered into the diet of Europeans and soon the production areas expanded from South America only (mainly in the Amazon basin and Andes mountains) towards European colonies in West Africa (Squicciarini and Swinnen, 2016)[16]. Post World War II there was a boom in cacao consumption and West Africa was already the leading production zone worldwide. Overtime, Colombia and other South American countries have switched towards different crops and cacao is not now a main crop.

Cacao farming and the environment

Cacao trees are very sensitive to environmental and weather conditions and just grow in high temperature and high humidity.[17] Therefore, many regions of Colombia are naturally endowed with the conditions necessary to invest in cacao farming. At the same time, few other countries can produce cacao and there is pressure to satisfy the cacao global demand.

Cacao trees take 3-5 years to produce fruits and peak production level is at around 10-15 years, subsequently trees decay at around 30-50 years (International Cocoa Organization, n.d.). Each cacao pod usually encases about 40 beans which are roughly 30% of the weight of the cacao pod, the rest is crop waste. Cacao trees can be damaged by pests and diseases and the most common pathogen (*Phytophthora palmivora, Moniliophthora roreri and M. perniciosa*) that causes black pod disease is one of the major threats for cacao farming. Traditionally, cacao trees were grown in natural or secondary forests, or in the shade of other crops as the biodiverse environment protects trees from diseases. Nowadays 'hybrid' species have been introduced and cacao trees can be planted in direct sun or thinned forest (Asare et al., 2018). However, the monoculture farming system is contributing to biodiversity loss, soil and water degradation and deforestation (Carsan et al., 2014; Obeng & Aguilar, 2015). Figure 11 reports the possible relationship between cacao monoculture, biodiversity and production intensity. Although cacao production is also influenced by weather, soil, labour and environmental conditions, the figure shows how alternative cacao farming systems present

13) Scientists studying cacao's evolution believe that *Theobroma cacao*, the species that is the source of cacao, evolved ten million years ago. Its relatives in the genus *Theobroma* consist of about 20 species with pods and seeds similar to cacao's (https://www.knowablemagazine.org/article/living-world/2018/searching-chocolates-roots-and-enemies-colombias-wilderness).

14) In France, Marie Antoniette was given health remedies in chocolate waffle (still known as Pistoles of Marie Antoniette) and in the UK, the diary of Samuel Pepys ('700) describes the luxury habit of drinking chocolate in London.

15) In 1795, Joseph Fry invented a method of grinding cacao beans and in 1828, Coenraad van Houten introduced the first processes to remediate the bitter taste of cacao and to extract cacao butter.

16) The cacao hybrids that are nowadays grown worldwide were created in Trinidad and Tobago and from there disseminated to the rest of the world.

17) Cacao trees need lots of rain and humidity, coarse particled soil with sufficient nutrients and organic matter and trees are very sensitive to soil water deficiency; excess water should be able to drain away.

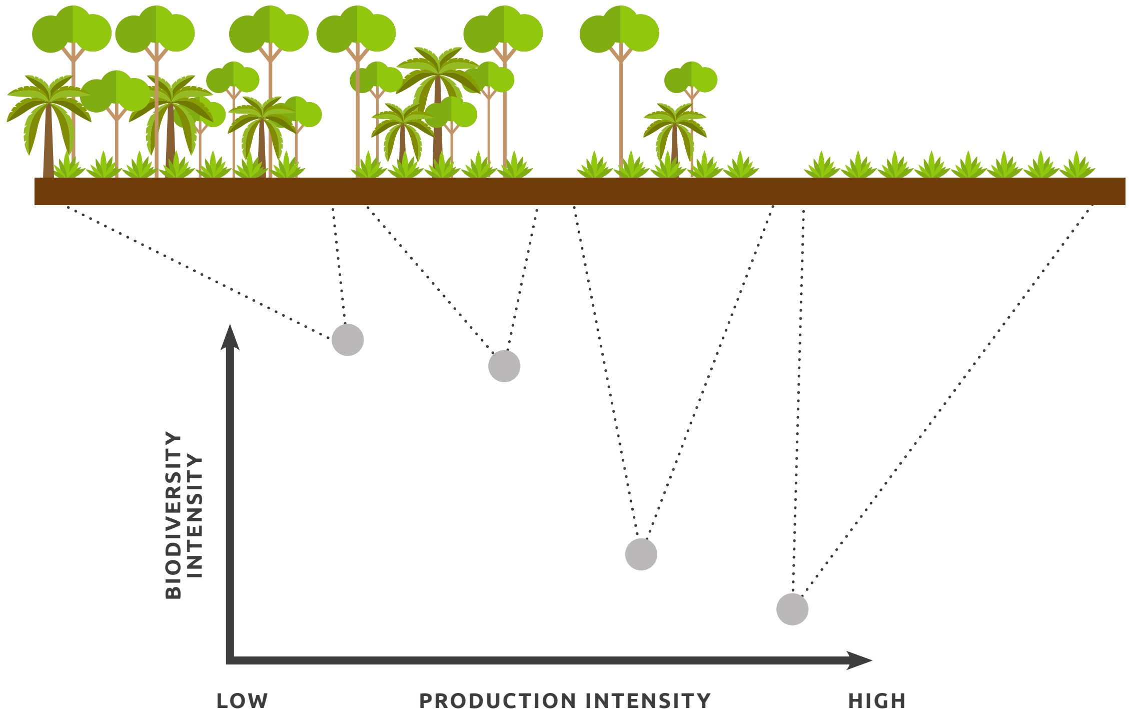


Figure 11. *Cacao farming systems and potential economic and environmental consequences*
Source: adapted from Norris and Wade, (n.d.)

sustainability trade-offs. Monoculture cacao farming is the predominant system in leading exporting countries (e.g. Ivory Coast, Ghana, Ecuador). It relies on persistent use of fertilizers and pesticides and the reduced labour costs and increased production yield are counter balanced by the environmental consequences (Donald, 2004; CocoaBarometer, 2018). In the last decade, alternative cacao farming systems have been studied and results show that agroforestry can represent a promising substitute.

Cacao agroforests (AFs) that retain a floristically diverse and structurally complex shade canopy have the potential to harbour significant levels of biodiversity. Cacao AFs provide several ecosystem services to society, for instance, they contribute to the fixation of atmospheric CO_2 and increase carbon stocks with an annual rate of accumulation of carbon in aboveground biomass ranging between 1.3 and 2.6 Mg C ha−1 y−1 (Somarriba et al., 2013). Middendorp et al. (2018) indicated that agroforests shaded by native trees could store up to 7% more aboveground biomass compared to monocultures. These agroforestry systems favour the diversity of species of flora and fauna as they function as buffer zones in natural areas, facilitate connectivity between remnants of vegetation, and serve as a refuge for several species of migratory birds (Ríos et al., 2017). In this regard, animal diversity is found to be higher in cacao agroforests with high plant diversity, structurally complex canopies, and abundant surrounding forest cover (Deheuvels et al., 2012; Schroth and Harvey, 2007). Retaining farm tree cover is beneficial for biodiversity through enhancing landscape connectivity and habitat availability (Schroth and Harvey, 2007). Finally, lower levels of forest fragmentation associated with cacao AFs were also found to be beneficial for pollinator diversity (Toledo-Hernández et al., 2017). A growing number of studies have demonstrated the environmental benefits of AF (e.g. Obeng and Aguilar, 2015). Evidence suggests that cacao AFs promote jointly biodiversity and ecosystem services (De Beenhouwer et al., 2013). There is evidence suggesting that pollination by cacao midges benefit from shade conditions (Groeneveld et al., 2010); and that that there is a positive relationship between shade management with ant species-rich communities which improve the financial performance of small-scale farms (Bisseleua et al., 2017; Tadu et al., 2014). Insect pests of cacao trees in AFs seem to be controlled by the diversity of arthropod communities (Klein et al., 2006) and reduced by the presence of a diverse shade canopy (Daghela Bisseleua et al., 2013).

The benefits provided by AFs are also related to food security and income diversification in the rural Colombian context. A study developed by Schneider et al. (2017) found that cacao yields in AFs were not significantly different when compared with conventional monocultures. Moreover, they found that the cumulative yields of all products harvested were significantly higher in the AFs (161% higher) compared to the monocultures. Finally, but not least important, lower levels of cadmium (Cd) leaf content have been found in AFs than in monocultures (Gramlich et al., 2016)

International initiatives have been launched to promote AFs, reforestation and avoid deforestation.[18] However, farmers are sceptical about agroforestry systems as they believe that shade trees increase humidity and thus susceptibility to disease infection (Anglaaere et al., 2011; Clough et al., 2009). Further the investment costs to switch to more sustainable cacao farming can be substantial as more workers with diverse skills are needed to manage the diverse crops and trees and new selling markets need to be identified (Millard 2011; Cerda et al., 2014). While we claim that the agroforestry system offers many incentives to strengthen the cacao farming system for a secure, sustainable, long productive sector, this system is not the only response to the multiple environmental pressures.

For this reason, a parallel GROW Colombia stream of research is focusing on preserving the genetic diversity of cacao trees in order to support the global cacao

18) The Cacao and Forest initiative is a platform of industry, major donors and West African countries that aims to promote sustainable cacao farming. The World Cocoa Foundation, IDH Sustainable Trade Initiative and the Prince of Wales are the main sponsors of the platform.

production system as it responds to market requirements, climate change and environmental issues[19]. Drought and soil deterioration are the main limits that the sector is facing along with pest and disease control. Therefore, innovative genetic materials or management strategies can represent solutions to increase cacao productivity and preserve biodiversity. Colombia and other cacao producing South American countries are also exposed to a high levels of soil cadmium that can have a negative effect on the profitability of the cacao sector. CacaoNet and ICOGen are setting up two databases to conserve the different varieties that can be used in future cacao breeding programs (e.g. Padi et al., 2017; Livingstone et al., 2011).

Cacao farming and social capital

Cacao farming is a labour intense farming activity and globally 90% of the cacao is produced by small holders. However, CocoaBarometer (2018) reports that cacao farmers suffer structural poverty, lack of basic services (e.g. schools, infrastructure) and are the main victims of price volatility. The sharp drop in the cacao price in 2016 imposed 30%-40% losses on smallholders' income.[20] They also suffered from the degradation of the natural environment that impacted productivity. Child labour remains at very high levels in the cacao sector, CocoaBarometer (2018) reports that in West Africa more than two million children are working in cocoa fields. There is a sector-wide objective to reduce child labour by 70%, and to empower farmers to develop a sustainable cacao economy.

The Global Cocoa Agenda adopted at the first World Cocoa Conference 2012 aimed at improving the wellbeing of cacao farming communities through their inclusion in the global cacao survey. CocoaBarometer (2018) reported a lack of success in improving the conditions of farmers and cacao workers. The sector is aging and has difficulty in attracting younger generations of farmers which could significantly impact global production of cacao.

The global cacao price is volatile and is influenced by the supplydemand balance for a particular origin and type of cacao

Cacao international market

On the cacao global market, three traded varieties exist: forastero, better known as 'bulk', criollo and trinitario, which are the varieties from which the 'fine and flavour' designation is derived. The quality and flavour profile of cacao beans is affected by the plant genotype, soil conditions, other ecosystem parameters, and postharvest treatments including fermentation (Kongor et al., 2016).

During the last decade, worldwide demand for special cacao has grown at an annual rate of 9% (Badrie et al., 2015; Contreras Pedraza, 2017; Ríos et al., 2017) and cacao is of significant economic importance both for producing and consuming countries (Figure 12). Producing countries are primarily Indonesia and African and Latin American countries. USA and European countries are the major consuming markets but new consumers in Russia and Asia are emerging. This increases pressure on producing countries that are experiencing a decrease in productivity due to pests, diseases and climate change.

The global cacao price is volatile and is influenced by the supply-demand balance for a particular origin and type of cacao (Figure 12). CocoaBarometer (2018) reports that between September 2016 and February 2017 there was a significant drop in the world market price due to an increase in the productivity of

19) Genetic diversity of Colombian germplasm includes all the variants of cacao found throughout its native range and can play a relevant role in supporting the industry (Osorio-Guarín et al., 2017). Colombia has 50% of the species of *Theobroma* therefore being the centre of *Theobroma* species and of *T. cacao* diversity.

20) Ghana was an exception as the government is indirectly subsidising cacao´s price.

PRODUCTION/CONSUMPTION

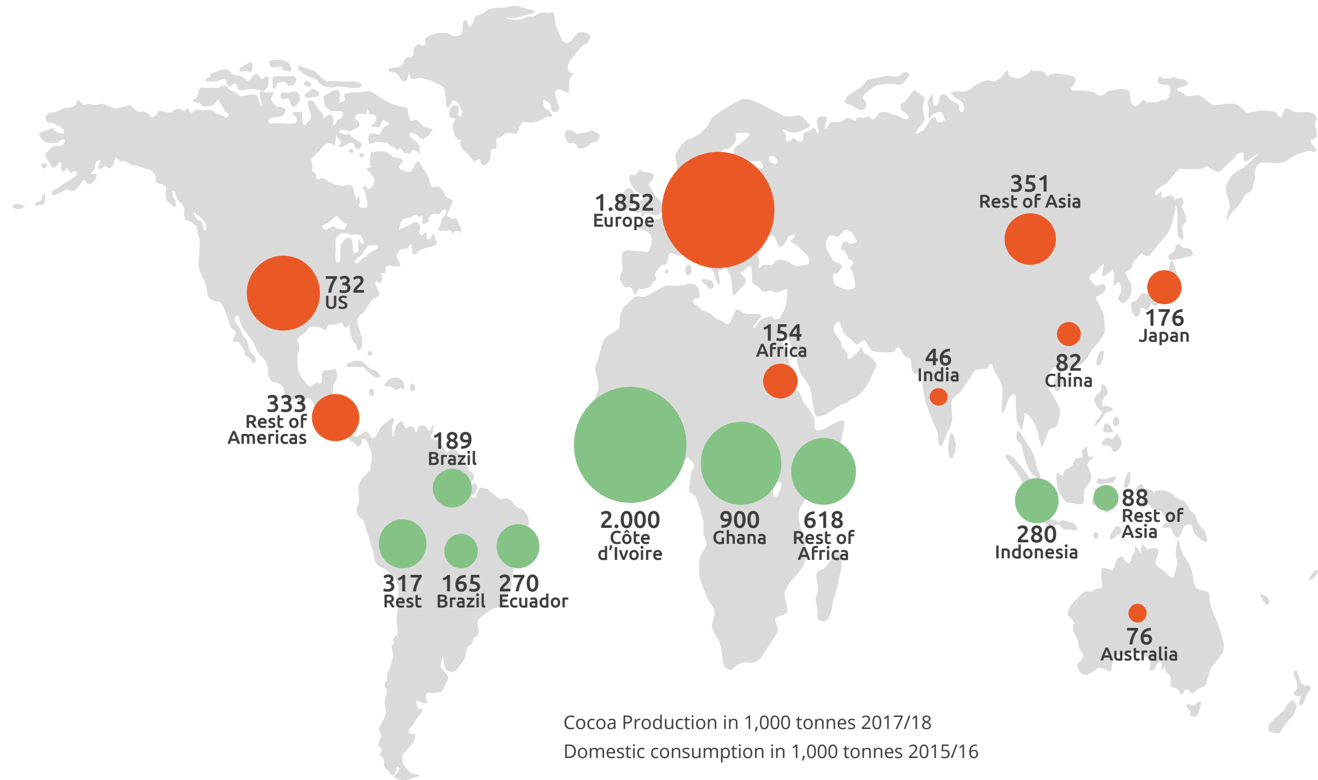


Figure 12. *Cacao production and consumption*
Source: adapted from CocoaBarometer, 2018

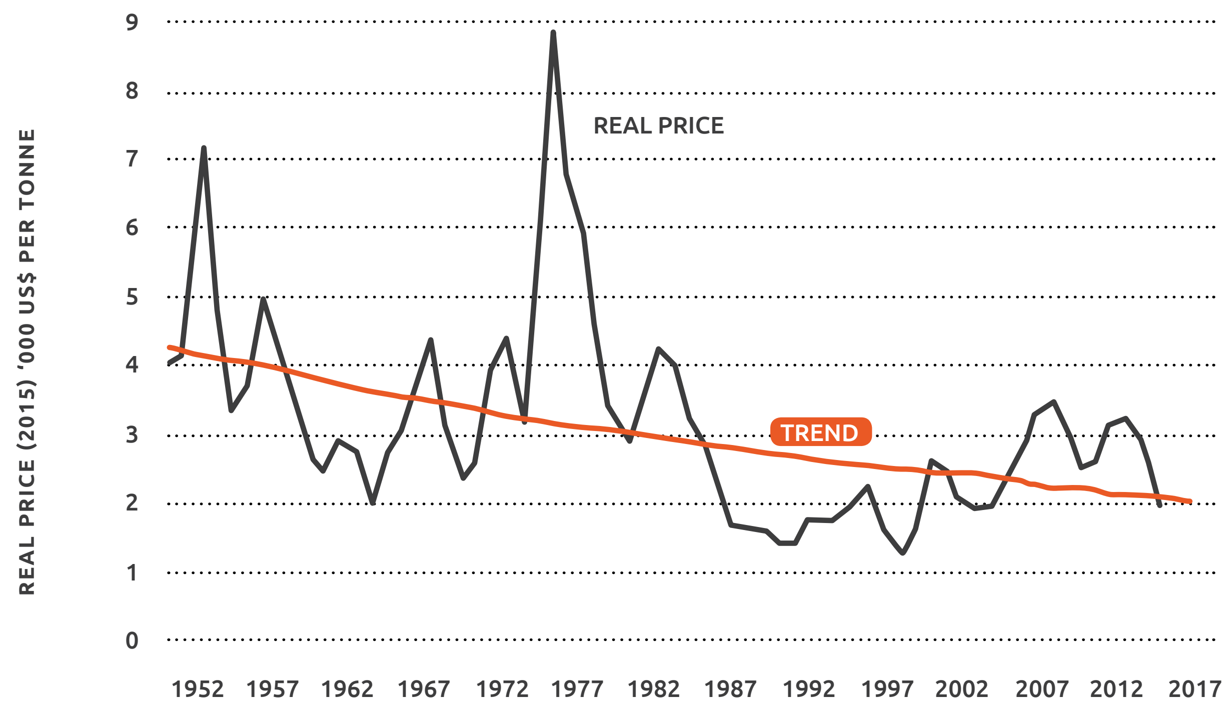


Figure 13. *Cacao prices between 1952-2017*

Source: adapted from CocoaBarometer 2018

African farmers who benefit from training and support programs of major cacao companies and favourable weather. Many actors perform along the cacao supply chain, but farmers are the most exposed to financial risks.

The flavour of cacao develops on the farm, as harvested pods are opened, and the processing of beans start. The beans get piled in heaps or wooden boxes and are fermented naturally by yeasts and bacteria, then dried in the sun on wooden platforms or cement/ground, where a gradual reduction in moisture content inhibits microbial growth. Beans are then bagged and marketed. Good quality fermentation/dry and timely delivery to market are essential to benefit from a price premium. However, a standardized protocol for bean processing is under investigation (Catapul project) and traders and retailers play a role in securing fair prices to farmers.

Ríos et al., (2017) suggests that worldwide special cacaos are sold for a premium of USD 1,000 per ton over the price of conventional cacao. *Special cacao* is characterised by outstanding sensory profiles *(fine flavour and aroma cacao)* and differentiating factors (see Table 2) such as origin *(Premium or origin cacao)*, the certifications obtained by their producers *(sustainable cacao)*, as well as cacao traceability and singularity (Chaux and Pérez, 2017).

Certifications/standards have played a role in differentiating the cacao markets and securing price premiums. Although

DIFFERENTIATING FACTORS	DESCRIPTION
Origin	The interaction of physical factors (soil, water, temperature) with the type of climate and geographic location influence the expression of the characteristics of a particular variety of cacao
Singularity	It determines the rarity of cacao in which other unique characteristics, both physical and organoleptic, also stand out; corresponds to crops with high specialisation in restricted production areas
Variety	The genetic group to which the cacao belongs determines to a great extent the physical and organoleptic characteristics that it will develop with an adequate management
Quality	A parameter that is the result of the interaction between genetics of a specific variety and post-harvest management
Management	The management of a plantation added to the activities of harvest and post-harvest are factors that determine the expression of the organoleptic properties of cacao[21]
Relevance	Its management stands out for influencing positively in the social, environmental or productive environment, generating significant social benefits or environmental services

Table 2. *Differentiating factors for special cacaos (Modified from Ríos et al., 2017)*

CacaoBarometer (2018) reports that "none of the standards have been able to significantly contribute to farmers achieving a living income, or even to lift farmers out of structural poverty." Table 3 reports the most popular international labels that aim to support farmers' livelihood and environmental protection. Some labels are specific for cacao (e.g. UTZ) others for agriculture products in general (e.g. organic). Some companies such as Hersheys and Mars have committed to increase their procurement of sustainable cacao, whereas Mondelēz has developed in-house sustainability programmes (e.g. Cocoa Life label).

Under pressure from the IMF and World Bank, in 1980 the cacao markets were liberalized in the hope that the demand-supply balance could boost the livelihood of the sector. Unfortunately, the liberalization has performed poorly in terms of raising the farm gate prices. Cacao prices

Certifications/standards have played a role in differentiating the cacao markets and securing price premiums.

21) Organisms that ferment the beans will have an impact on flavour and will differ depending on the region in which the trees are grown. Therefore, varieties grown in different regions might have different flavour due to different fermentation organisms.

Table 3. *Different certification strategies operating in the cacao market*

CERTIFICATION	LOGO	YEAR	DESCRIPTION
Fairtrade	FAIR TRADE CERTIFIED / FAIRTRADE	1994 Max Havelaar Foundation arranged fair trade certification.	The label supports the creation of cooperatives/ associations, monitor on limited used of chemicals and no child labour. It guarantees a minimum export price of $2000/tonne.
US/EU organic	USDA ORGANIC	USDA was approved in 1990. In 1991, EU defined the rules for responsible use of resources, environment and biodiversity. Authorized certification bodies test that the product is compliant with rules.	In the cacao sector, EU recently requires buyers to satisfy additional requirements, especially in the field of food safety certification, Corporate Social Responsibility (CSR) and sustainability.
Rain forest alliance	RAINFOREST ALLIANCE CERTIFIED	It was founded in 1987 by Daniel Katz and aims to promote sustainable forestry, agriculture tourism. Recently it merges with UTZ and in 2020 the new program would be launched.	Farmers must meet the Sustainable Agriculture Standard that aims to conserve ecosystems, protect biodiversity and waterways, conserve forests, reduce agrochemical use, and safeguard the well-being of workers and local communities
Sustainable farming of coffee, cocoa, tea and hazelnuts	UTZ Certified	In 2002 Nick Bocklandt, a Belgian-Guatemalan coffee grower, and Ward de Groote, a Dutch coffee roaster proposed the certification of sustainable farming for coffee, cacao, hazelnuts and tea.	Farmers should follow sustainable cacao farming system to favour shaded cocoa systems, fair social and living conditions and adequate farm management.
ISO 34101		July 2019 the new ISO sets the requirements for cacao sustainability management systems that includes economic, social and environmental requirements.	

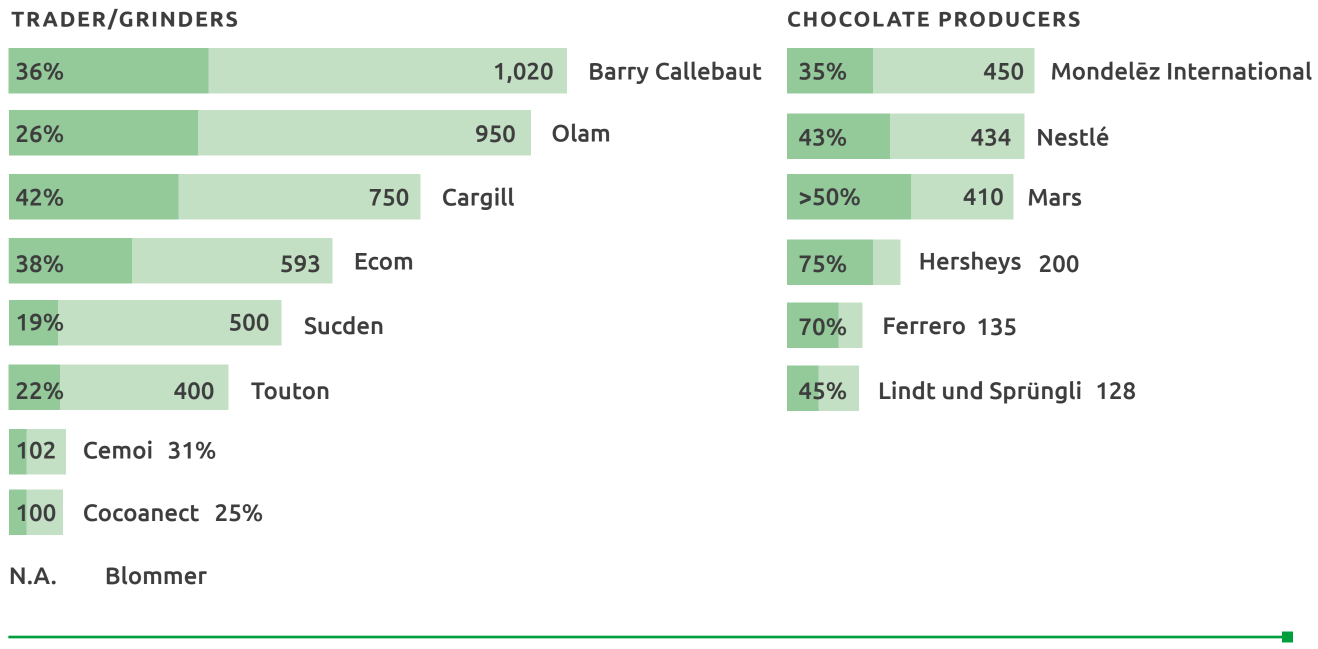


Figure 14. *Cacao retailers and chocolate producers. In dark green their proportion of certified cacao and in light green total cacao in 1000 tonnes used in 2017.*

Source: adapted from CocoaBarometer, 2018

are set at the futures market that is frequently dictated by computer algorithms and farmers have minimum control on their cash crop. Further the global cacao market exposes farmers to international competition coming from new producing countries (e.g. Indonesia) or countries which subsidise production (e.g. Ghana). Globally a few major producers and retailers (Figure 14) control the market and their investments in certified cacao is still limited.

The cacao industry differentiates between cacao traders/grinders and chocolate manufacturers. The former usually cover all activities for processing the beans in cacao products, including nib, liquor, butter, and powder. The chocolate manufacturers are responsible for mixing the cacao with other ingredients to obtain market chocolate products like chocolate bars. Both players have a relevant role in sourcing and using certified cacao. Figure 14 summarises the proportion of certified cacao sourced by the main international retailers and chocolate producers. Certified cacao generally represents a small proportion in the industry, with some exceptions such as Cargill that is the most active trader in resourcing certified cacao, and Hersheys and Ferrero that are dominating the category of chocolate producers for their attention to certification.

García-Herrero et al. (2019) confirm that consumers are demanding more sustainable chocolate products although the consumption is frequently associated with social, cultural meaning that provide rewarding emotional feelings (Squicciarini and Swinnen, 2016). Chocolate contains theobromine, a psychoactive alkaloid content, which has mildly stimulating and slightly addictive effects. At the same time, chocolate can produce positive health effects such as the prevention of cardiovascular diseases, improving periodontal health; effects on neurons; possible anti-tumour effects; anti-inflammatory effects and anti-obesity effects (Araujo et al., 2016; van Wensem, 2015). In European culture, chocolate is given as a gift more than any other food and is almost expected in certain holiday settings as a consequence the consumption is stable or slightly growing every year. Research shows (Squicciarini and Swinnen, 2016) that the European market is close to saturation, but newer markets are emerging (e.g. Russia, China and India) and the global demand may not be matched by the global supply by 2024.

Chocolate is a complex food with producers, traders, retails and consumers frequently located in different geographical zones and with a long supply chain. Recent life-cycle analysis studies report multiple environmental impacts in the different stages of production (Recanati et al 2018) and the possibility that consumers cannot fully assess the sustainability of certificated chocolate products. García-Herrero et al (2019) suggest that current labelling systems are not fully communicating the sustainable cacao initiatives and a gap in communication exists.

Consumers are demanding more sustainable chocolate products as these are frequently associated with social and cultural meaning that provide rewarding emotional feelings.

More recently, the major companies are investing in their Corporate Social Responsibility activities to mitigate the social and environmental effects of cacao production and key international organizations are supporting and monitoring the sector. Major organizations/initiatives are summarized in Table 4 although other organizations are specifically operating in West Africa as for example the Child Labour Monitoring and Remediation Systems in which cacao producing communities protect children and their rights.

Colombian cacao market

In 2011, the Colombian Government created the National Policy of Consolidation and Territorial Reconstruction[23], which aims to protect the fundamental rights of the population of territories historically affected by the armed conflict and illicit crops. One of the strategies of this program is to develop productive projects, such as agroforestry and agricultural production, which are capable of providing livelihood to growers (Ministerio de Justicia, 2003). Cacao farming stands out as a rural development strategy in the post-conflict Colombia and has been adopted by the government as the strategic crop to support families with the initiative “Cacao, Forest, and Peace”[24] led by the World Cacao Foundation (Ministerio de Agricultura y Desarrollo Rural, 2018).

Colombia has the potential to participate in the fine chocolate market since the genotypes that are grown in the country have achieved worldwide recognition for their quality and can be positioned in the niche of special cacaos (USAID et al., 2017). The country is already ranked as the 10th largest cacao bean producer worldwide (Ríos et al., 2017) and represents

22) In November 2018, Biodiversity International and the International Center for Tropical Agriculture (CIAT) joined forces in the Alliance of Biodiversity International and CIAT.

23) Política Nacional de Consolidación y Reconstrucción Territorial (PNCRT).

24) “Cacao, Bosques y Paz”.

Table 4. *Major International Cacao Initiatives*

YEAR	INITIATIVE	DESCRIPTION
1973 (ICCO)	International Cocoa Organization (ICCO)	The organization collects research findings, organizes conferences and support sustainable cacao production. Member countries represent almost 85% of world cacao production and more than 60% of world cacao consumption.
2000 (World Cocoa Foundation)	World Cocoa Foundation It was incorporated in the former U.S. Chocolate Manufacturers Association established in 1995.	The mission is to train farmers and to strengthen the sector to guarantee cacao production and communities’ livelihood. It promotes charitable activities and public-private partnerships that could raise funds through contributions, grants and outside donors, allowing it to access larger networks and support farmers across the global. They organize the world cacao conference.
2017 (Cocoa & Forests Initiative)	Cacao and Forest Initiative promoted by the WCF	More than 25 companies in a joint-partnership with governments to end deforestation in the cacao sector.
2008 (Cocoa of Excellence)	Cocoa of Excellence It is founded by Bioversity International[22], Event International and CIRAD with support from the Common Fund for Commodities (CFC), ICCO, Guittard, Barry Callebaut, Mars and Puratos.	They promote the diversity of cacao and offer market opportunities and provides incentives to safeguard cacao diversity for the benefits of the entire value chain, from the farming communities to the consumers. Every two years they assign the International Cocoa Awards.

approximately 75% of the net income of 35,000 families in rural Colombia. Although the cacao yield in Colombia has remained flat for the past 60 years (average yield of 0.5 ton/ha. by the year 2017), the country's total cacao production grew from 36,731 tons in 2000 to 54,796 tons in 2015 (DANE, 2014). The production increase was mainly explained by the extension of the harvested area (98% change) which started with 83,138 ha in 2000 and extended to 165,006 ha in 2017 (USAID et al., 2017). The main producing areas are located in the departments of Santander[25], Antioquia[26], Nariño[27] and Arauca[28].

Approximately 74.5% of the total cacao production remains in the country (Red Nacional Cacaotera, 2016). The national market is controlled by large companies which often underpay the cacao bean producers as they do not meet the premium quality standards defined in the Normas Técnicas Colombianas 1252 (Contreras Pedraza, 2017). Over 80% of the national cacao production is bought by two Colombian companies: Casa Luker and Nutresa[29]. Regarding the international market, cacao exports have increased by 560% in the last ten years, with 95% of these exports (13,056 tons) being of 'fine and flavour' cacao (USAID et al., 2017).

The competitiveness of the Colombian cacao sector in the first stage of the value chain is threatened by environmental factors limiting productivity, such as the ageing of crops, inadequate seeds or genetic material, shade excess or deficit and bad tree structure, as well as the presence pests and deseases. Crop infection with pathogens *(Moniliophthora roreri, Moniliophthora perniciosa and Phytophthora sp.)* and parasites *(Rosellinia sp.)* have generated significant production losses (about 50%) and have increased farmers production costs (Instituto Colombiano Agropecuario, 2012). Socio-economic issues have also been identified in the country's cacao value chain. For instance, the low technological development of the value chain; unequal distribution of income; problems of associativity (e.g. in forming cooperatives and unions), trust and integration of agents of the chain; as well as the ignorance of the parameters of quality or requirements of international markets from producers and marketers (Contreras Pedraza, 2017; Ríos et al., 2017). The latter issue is of particular importance since cacao from Latin America often exceeds the permitted concentrations of cadmium (Cd) by international regulations (Gramlich et al., 2016), such as "Proposition 65" in California[30], and the EU Regulation 488/2014[31]. Cd causes health concerns as it is retained in the human kidney (biological half-life of 10–30 years) and accumulation effects of highly daily doses can produce cancer, renal dysfunction, osteoporosis, and cardiovascular diseases (Järup and Åkesson, 2009; Satarug et al., 2010; World Health Organization, 2010).

Although Cd is naturally released into soils through weathering of rocks, Cd contamination of food is caused by widespread low-level contamination of soil mainly derived from anthropogenic activities such as mining, smelting, the development of the microelectronics industry and the application of rock fertilizers (Clemens et al., 2013; Gramlich et al., 2016). Bravo et al. (2018) identify that in Colombia the primary anthropogenic sources of cadmium are soil management practices, crop rotation and

Colombia has the potential to participate in the fine chocolate market since the genotypes that are grown in the country have achieved worldwide recognition.

25) Approximately 31.25% of the national production.
26) Generates 8.36% of the national production.
27) It represents 8.25% of the national production.
28) Approximately 6.71% of the national production.
29) Formerly Grupo Nacional de Chocolates S.A.

30) The Office of Environmental Health Hazard Assessment (OEHHA, 2001) established that the maximum allowable daily level for cadmium exposure for Reproductive Toxicity for Cadmium by the oral route is 4.1 µg/day.
31) The European Food Safety Authority (EFSA) established a tolerable weekly intake (TWI) of 2,5 µg/kg body weight for cadmium (EU, 2014).

soil amendments (particularly with phosphate fertilisers).

Even though Colombia's cacao production mainly depends on traditional smallholder cultivation systems (Ríos et al., 2017), recently, there have been some initiatives to promote AFs in the country. On-farm benefits of agroforestry alone are insufficient to justify the adoption, as farmers need to benefit from the cacao price premium as well as payment for the ecosystem services protected or enhanced by AF systems (Asare et al., 2014). For instance, farmers are currently receiving an insufficient price increase for the added labour associated with appropriate post-harvest practices, such as careful fermenting and drying correctly. The current premium paid in Colombia to farmers adopting post-harvest practices is estimated to be COP$200 per kilo ~ USD 62 per ton (USAID et al., 2017) and USD 300 per ton to farmers growing special cacao (Ríos et al., 2017). However, USAID et al. (2017) suggested that a price premium of around COP$1000 per kilo ~ USD 300 per ton is necessary, to make the adoption of better management practice viable for farmers.

Research is needed to explore whether farmers are willing to engage in sustainable ways of production that provides them with livelihood alternatives.

Currently, there are insufficient financial incentives to encourage farmers to enter the cacao market. The premium prices for growing special cacaos do not appropriately reflect farmers' additional effort for growing sustainable cacao. Therefore, there is scope for implementing additional financial incentives, such as payments for ecosystem services (PES) or certification schemes which incentivise smallholder farmers to switch from their current management practices (i.e. illicit crops or non-sustainable cacao production). This opportunity is reinforced by the establishment of a Zero Deforestation Pact, signed in July 2018 between the Ministry of Environment, Casa Luker, The Sustainable Trade Initiative and the World Resources Institute – WRI, as part of the Cacao, Forests and Peace agreements[32]. The agreements seek to incorporate practices and technologies that enhance cacao production, help to close the agricultural frontier, make a sustainable land use protect strategic ecosystems and ensure that the establishment of this crop does not promote forest deforestation or degradation (MADS, 2020)

32) The agreement is available at: https://www.minambiente.gov.co/images/BosquesBiodiversidadyServiciosEcosistemicos/pdf/Acuerdo_cero_deforestacion/cacao.pdf

Photo: Neil Palmer/CIAT

Research objectives

On the demand side, research needs to explore whether consumers have a willingness to pay (WTP) higher premiums to obtain a product with flavour qualities, but also to pay for the social and the environmental benefits derived from growing sustainable cacao beans in rural Colombia. Estimating the WTP for Colombian special cacaos can provide further insights on the magnitude of the premiums in this market. However, if consumers have a positive WTP for premium cacao, it is also relevant to explore consumers preferences for cacao farming features.

On the supply side, research is needed to explore whether farmers are willing to engage in sustainable ways of production that provides them with livelihood alternatives.

Environmental valuation studies surveying farmers, commonly estimate their willingness to accept, and the willingness to participate, in management options that generate changes in the natural state of the environment. Gibson et al. (2016) have suggested using payment vehicles based on money whenever there are functional markets. However, there is scope for testing the use of labour contribution (willingness to work) as the payment vehicle in the rural Colombian contexts where cash income might be low, and there are large percentages of the population not engaged in waged labour (i.e. barter or work exchange).

Exploring the farmers' willingness to engage and participate in sustainable ways of producing cacao, is as relevant as exploring their preferences within the wide range of AFs management practices. In this regard, the present study could improve the understanding of their preferences for the different practices used for improving crop productivity (e.g. shade complexity, income source diversification, pest and Cd levels management, adequate post-harvest practices, associativity); as well as identifying means to influence their preferences for opting out from illicit crop markets. For instance, this research could be useful to determine whether there is a spillover effect of information, whether conditional collective incentives bonus[33] could be helpful (Kuhfuss et al., 2016), or to determine if the social pressure would affect farmers' behaviour. Dumont et al. (2014) argues that the transference of knowledge, between farmers and scientists, have helped to improve cacao shade-tree management to implement certification schemes for cacao and has been instrumental in promoting diversity in AFs. Therefore, the design of cacao AFs should also take into account farmers' knowledge, expectations (Jagoret et al., 2014) and preferences.

33) Landscape conservations versus farm conservation

Field activities in the Choco cacao expedition, March 2019

Photo: Jaime Erazo

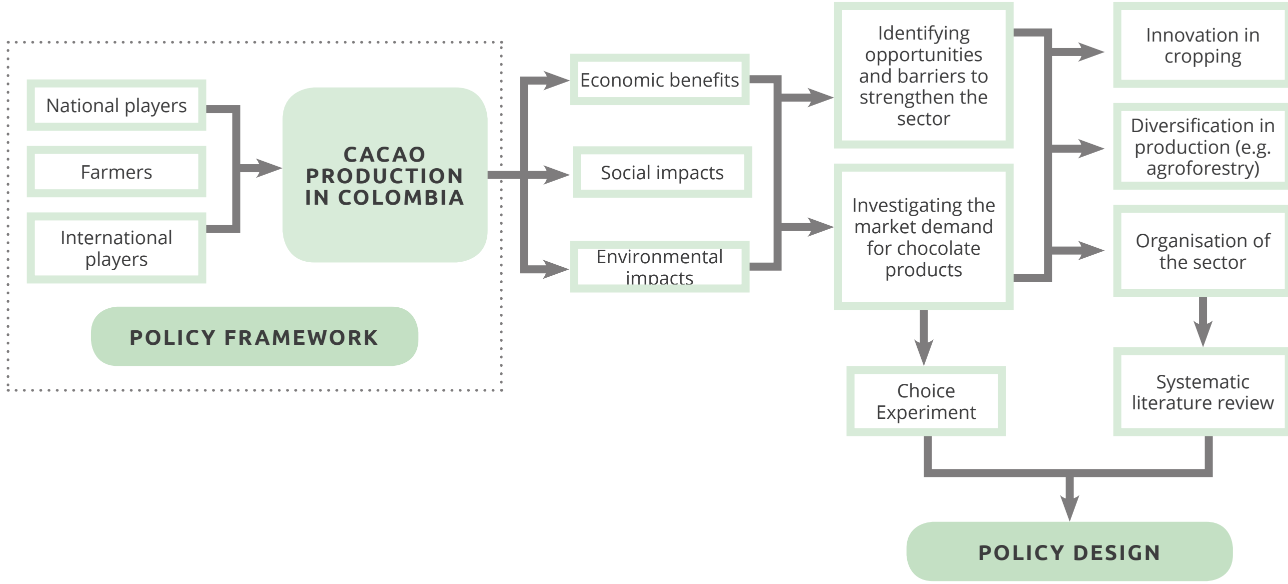


Figure 15. *Visioning and planning for sustainable cacao opportunities*

Research methods and approaches

The research framework follows the scheme of Fig. 15 and the design of the policy interventions is supported by the study of the consumers' demand and producers' interest in implementing alternative cacao production systems.

Exploring consumers' preferences for sustainable cacao products is not only relevant to determine the existence of a price premium for cacao from AF systems, but could also help to identify the environmental and social attributes that have stronger impacts on consumers' preferences. This information can be trivial in informing producers towards sustainable cacao systems. The producers' preference for cacao agroforestry practices is another key information to design policy intervention however the possibility to survey producers is limited by their geographical distribution and difficulties to directly contact farmer as such the revision of literature will be the research method and it will draw conclusions on current barriers to implement AF systems.

Finally, analysing consumer and producer information in unison might help us to understand whether there is a balance or mismatch on the demand and supply side of the cacao market in Colombia. It will also allow the identification of the aspects that need improvement in the cacao value chain, so that the supply of cacao could meet the requirements of the demand.

Sustainable Cattle Ranching

3 Sustainable cattle ranching

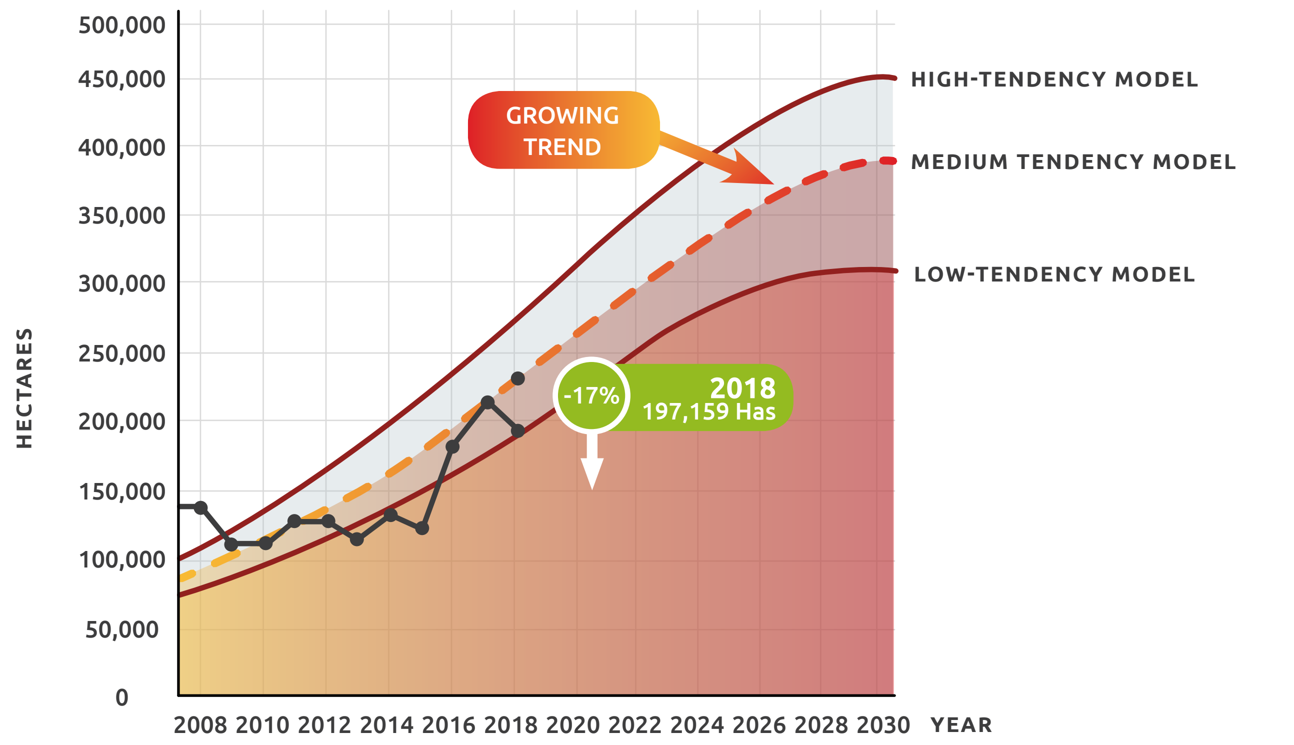
Historically, agriculture has been one of the main engines of Colombian economic development. The agricultural economic activity still contributes over 6% of the country's GDP and 4% of the value of exports (World Bank, 2018). Livestock farming, in particular, is an activity of great importance for both the rural economy and the country's food supply. The livestock sector contributes more than half of the agricultural value added, adding 3.5% to the national GDP, as well as directly generating 950,000 jobs (Fundacion CIPAV, 2018). This figure represents a quarter of the total jobs in agriculture, and almost 7% of total employment.

The livestock sector in Colombia is made up of a significant number of smallholdings; Fundacion CIPAV (2018), for example, reports that 82% of Colombian farmers own fewer than 50 animals. Such cattle ranchers face a very different set of challenges than large, industrial producers. Chen and Ravallion (2006), for example, highlight that an estimated 80% of the total number of people suffering from food poverty worldwide live in developing countries, and that half of them are small-hold farmers. Therefore, improving the welfare of smallholder farmers in developing countries represents a vital step on the path to achieving food security and sustainable development (Chappell and LaValle, 2011), directly targeting Sustainable Development Goal 2, which aims to end hunger and enhance food and nutrition security (United Nations, 2018).

According to the 2016 Colombian National Agricultural Survey, more than 37 million hectares (32% of the entire national territory) are dedicated to livestock farming, although more than half of this area is not considered to have the environmental characteristics that would make it suitable for grazing (DANE, 2016b). Given that the same source puts the estimated overall number of heads of cattle in Colombia at 22.9 million, the average stocking rate is just above 0.6, implying that each head of cattle uses in excess of 1.6 hectares of Colombian land. With this in mind, it is clear why extensive cattle ranching systems in Colombia have long been characterized as having low land use efficiency and low productivity (e.g. Mahecha, 2003) also typically associated with high environmental impacts (e.g. greenhouse gases and water pollution, WWF-Colombia, 2017).

As highlighted in Turner et al. (2020), extensive farming is one of the key drivers of land degradation in Colombia and is considered the main engine of deforestation and loss of biodiversity in the country (Lerner et al., 2017). According to the deforestation report from the Ministry of Environment, in 2018 a total area of 197,159

Figure 16. *Deforestation in Colombia between 2008 and 2018 (ha)*
Source: adapted from Instituto de Hidrología Meteorología y Estudios Ambientales (IDEAM), 2018



hectares (slightly more than Greater London) was deforested in Colombia (Fig.16). Despite this representing a reduction of 17% relative to the projected trajectory of the mean deforestation model, current projections still predict that in the long run deforestation in Colombia will increase. By the end of President Duque's current mandate in 2022, total deforestation is expected to reach 300,000 hectares, a total that would increase to 400,000 ha/year by 2030 (MADR-UPRA, 2018).

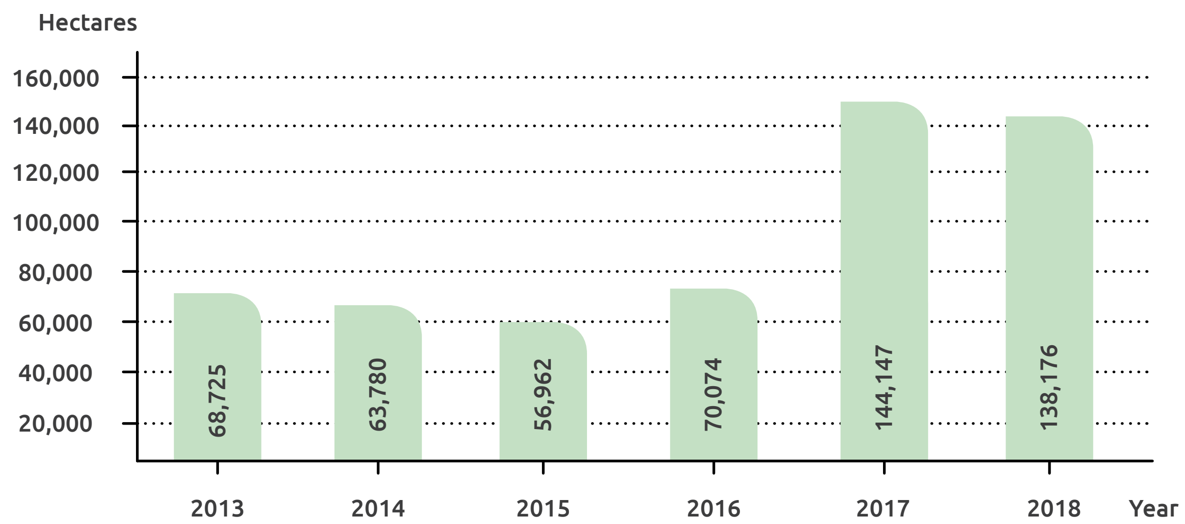
Figure 16 reports the trend of deforestation between 2008 and 2030, and the current deforestation rate is depicted in black. The figure shows an upward trend since 2015, despite the recent drop in 2018.

Restricting our focus to the Colombian Amazon, Figure 17 highlights that between 2015 and 2017, deforestation has increased by 153%, with a small reduction between 2017 and 2018 (4%, or 5,971 ha). Despite the decrease, Amazonian deforestation in 2018 represented 70% of the total deforestation in the country, a marked increase from 65% in 2017 and 39% in 2016.

At the department level, four out of the six most deforested areas are located in the Amazon: Caquetá, Meta, Guaviare and Putumayo. Two municipalities in Caquetá in particular had nearly 19% of the total Colombian deforestation for 2018: San Vicente and Cartagena de Chairá. These two municipalities have consistently ranked first and second in terms of deforested area between 2012 and 2017 (Figure 18).

In 2018, the Ministry of Agriculture defined the 'agricultural frontier' as "the limit of rural soil that separates areas where agricultural activities are developed, conditioned areas and protected areas, those of ecological importance and other areas where agricultural activities are excluded by law" (MADR, 2018). This definition is important as it prompts multiple policy options to try and stop deforestation and to make a coordination of policies between the environmental and agricultural sectors.

Figure 17.
Deforestation in the Colombian Amazon 2013-2018 (ha)
Source: adapted from Instituto de Hidrología Meteorología y Estudios Ambientales (IDEAM), 2018



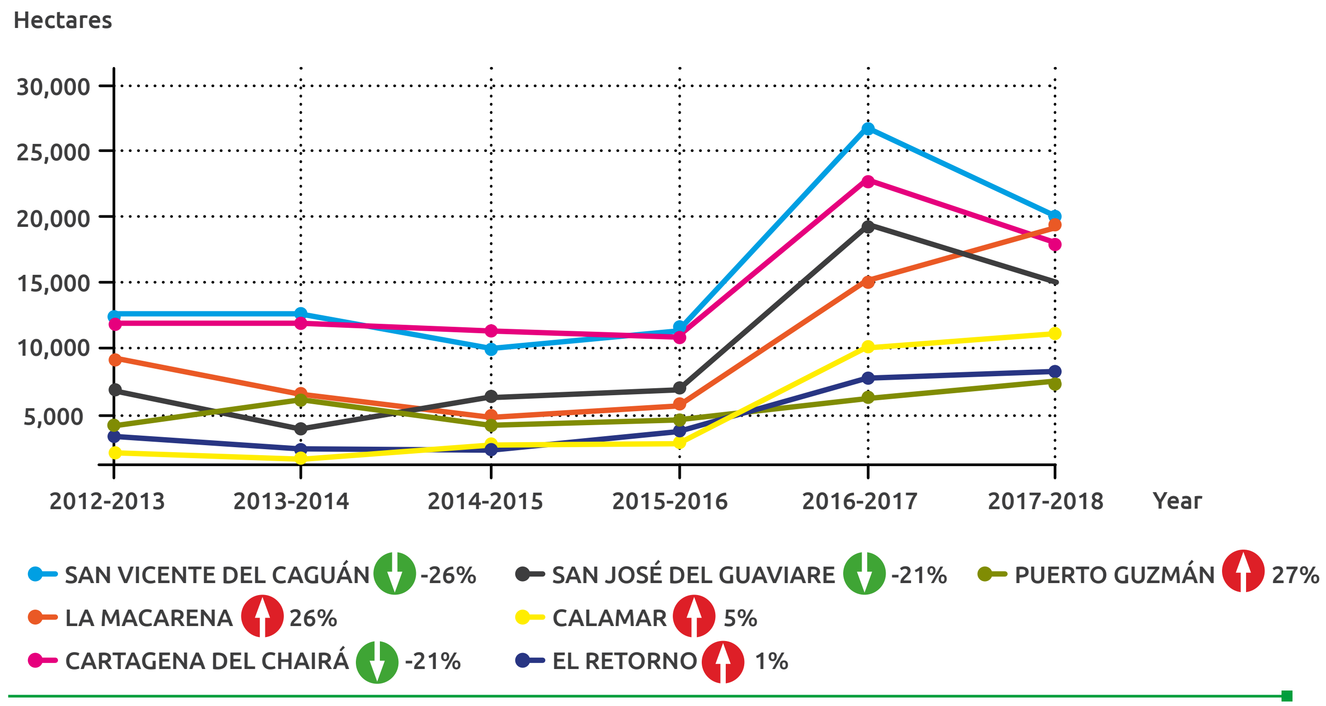


Figure 18.
Deforestation trends in most deforested municipalities (2012-2018)
Source: Instituto de Hidrología Meteorología y Estudios Ambientales (IDEAM), 2018

More than 80% of Colombian deforested land is currently used for cattle ranching (Calle et al., 2013). The simplest, most common cattle ranching system in Colombia consists of pasture lands without shrubs or trees. Areas devoted to such practices are both less biodiverse and more vulnerable to fires and to the deleterious effects of invading species (e.g. Suarez et al., 1998; Rivera et al., 2008). Livestock farming generates particularly significant impacts on low tropical forests, Andean forests, paramos and wetlands (Chará et al., 2011b). The loss and degradation of biodiversity is a significant driver behind both the negative changes in system productivity and in ecosystems functioning, leading to a lower stock of natural capital and a reduced flow of ecosystem benefits (Tilman et al., 2012).

A better understanding of the full spectrum of environmental, social and economic cost and benefits associated with switching to silvo-pastoral systems (SPS) in Colombia is needed to help to assess whether the total benefits outweigh the total cost and subsequently, to develop policy recommendations (e.g. in the form of PES schemes).

Silvo-pastoral systems and their potential benefits

In the last decade, silvo-pastoral systems have been actively promoted in Colombia and elsewhere as a means of meeting development pressures while mitigating the environmental costs of cattle ranching. These production systems are a form of agroforestry that intensifies livestock production through an improved use of ecosystem services and may lead to sustainable land use (Gumucio et al., 2015). They are characterised by a combination of trees, shrubs, forage resources and animals in the same agricultural system (Calle et al., 2009; Sanchéz Matta et al., 2009). For these reasons, SPS may be used to enhance biological diversity and the provision of ecosystem services (e.g. water regulation, carbon sequestration and biodiversity conservation) in cattle-dominated landscapes (Mosquera et al., 2012; Murgueitio et al., 2011; Rivera et al., 2013). SPS may also increase productivity and financial returns to farmers.

Silvo-pastoral systems are considered particularly appealing because of their presumed social and economic benefits. Their use could lead to higher economic benefits to farmers through the rise in cattle productivity, both in terms of milk and meat, as well as the potential diversification of farmers' sources of market income. In fact, cattle grazing under tree shade has been shown to be associated with higher production of milk and meat, as it allows cattle to graze more at lower respiratory rates and reduces the heat stress levels they suffer (Montagnini and Finney, 2011). Technoserve (2019) quantifies the average financial benefits of implementing SPS in different regions of Colombia and estimates that after 9 years of implementing SPS there are: 25% increase in milk productivity (l/ha/year), 26% increase in animal load (LLU/ha), 114% increase in daily body weight gain[34], 9% reduction in milk production costs and 13% incremental in annual income (compared to 3.4% for base line). Additionally, trees are a potential source of firewood and fodder, therefore providing additional streams of revenues to farmers (Montagnini and Finney, 2011). Chappell and LaValle (2011) also conclude in their review of the existing literature that SPS can contribute to achieving food security in developing countries.

Multiple complementary environmental benefits are associated with SPS. Tree conservation and planting may enhance soil fertility. Martínez et al. (2014), for example, reported that a SPS implemented in the Colombian Sinu River Valley region, contributed significantly to the nutrient cycling via litter production and decomposition, therefore increasing soil reaction and soil quality parameters. A study in the Jabonal water shed river, Costa Rica, showed that soil erosion reduced by nearly 46% in participating farms (Technoserve, 2019). The use of shrubs can also help to improve pasture productivity and provide farmers with a source of nutritional cattle food (Paciullo et al., 2011; Sousa et al., 2010) that can reduce farmers' dependency on commercial inputs. The structural and biological complexity of SPS increases the connectivity among forest habitats as well as providing nursery services and sources of food for wildlife species in Colombia, such as birds[35], mammals, reptiles and invertebrates[36]. Indeed, evidence has shown that, in comparison to conventional farming systems, the implementation of SPS worldwide has resulted in greater diversity of medium-sized mammals (Pineda-Guerrero et al., 2015), and improvements in key bio-indicator species such as ants (Ramírez and Enríquez, 2003; Rivera et al., 2013), as well as species which promote the recovery of ecological processes in ecosystems, like dung beetles (Giraldo et al., 2011). The abundance of beetles, in terms of population size, increased 47% when comparing pasturelands without trees and SPS. Also, dung beetles increased by 53% the amount of mobilized dung comparing improved pastureland with SPS (Technoserve, 2019).

Silvo-pastoral systems are appealing agricultural strategies as they provide social benefits and higher economic returns as the farmers can diversify the production.

Finally, the implementation of SPS in Colombia could help to promote reforestation, avoiding cattle ranching expansion in pristine forests and minimize cattle ranching environmental impacts. In this regard, a life cycle analysis of alternative farming systems in the country (Rivera et al., 2016) found that farms using silvo-pastoral management practices have lower emissions of greenhouse gases (2.05 vs 2.34 kg CO2-eq) and required 63% less non-renewable energy for each unit of milk produced than conventional farming practices[37]. Molina et al. (2008) reported that the adoption of silvo-pastoral systems based on Leucaena leucocephala in three Colombian departments (Tolima, Caldas and Valle del Cauca) resulted in an increase of 20% and 40% in milk and meat production. It therefore seems reasonable to conclude

34) The quantity and quality of forage produced under SPS and intensive SPS allow cattle to reach their maximum weight faster.

35) The Regional Silvopastoral project found that silvopastoral systems present equal or higher birds diversity (Shannon index approximately 0.8) than, secondary vegetation, waterfront forests, secondary forests, improved pasturelands without trees and natural pasturelands without trees. Also, they found 32% increase of total birds' species, 41% increase in bird species dependent on forests and a 90% increase in migratory species (Technoserve, 2019).

36) The Regional Silvopastoral project found a 0.82 correlation between vegetation cover and entomofauna diversity (Technoserve, 2019).

37) The estimations include the energy usage involved in the transport of fertilizers and production of other forages, distribution of inputs, fuel combustion during the production of inputs, among others.

A traditional livestock system in Colombia's southwestern Cauca Department.
Photo: Neil Palmer ©CIAT

that a switch from conventional cattle farming to a silvo-pastoral regime can produce both financial and environmental net gains. In this sense, it might fit the profile of a "production through conservation and conservation through production"[38] investment within an ecological macroeconomic strategy.

Silvo-pastoral systems initiatives in Colombia

Between March 2010 and January 2020 the Mainstreaming Sustainable Cattle Ranching Project was developed in Colombia. It was inspired by the potential socioeconomic and environmental benefits identified by the GEF funded project "Integrated Silvopastoral Approaches for Ecosystems Management" implemented in Costa Rica, Colombia and Nicaragua between 2003 and 2007. The objective of the project was "to promote the adoption of environment-friendly Silvo-pastoral Production Systems for cattle ranching in Colombia's project areas, to improve natural resource management, enhance the provision of environmental services (biodiversity, land, carbon, and water), and raise the productivity in participating farms" (World Bank, 2020). This was one of the first efforts at country level, working across 5 different regions[39], with the objective to reduce the impact of cattle ranching and to identify improvements in ecosystem services generated by the transition to SPS. Preliminary results were published in October 2019. Key insights included: 4,388 ha converted to intensive SPS; 60,158 ha (1520 farmers) under PES-1 (biodiversity) scheme; 3,967 ha (1,341 farmers) under PES-2 (carbon) scheme; 21,294 cattle ranching farmers sensitised and trained on SPS and sustainable cattle ranching production systems; 654 professionals and technicians trained on SPS; 50 focal plant species used/ conserved in cattle ranching farms (25 of which are globally important species). These results were supported by changes that have had an impact at the landscape level through identified conservation corridors, with actions like: a) in the Cesar river valley, 37% of total land uses adopted sustainable systems, that is nearly 25% of registered producers; b) in 56% of the total converted area (nearly 27,000 ha), cattle ranchers implemented dispersed trees through natural regeneration; c) in 38% of converted area dispersed trees were planted; d) producers adopted new technologies like dividing land and livestock rotation (86%), protection and reforestation of riparian areas (73%), use of organic compost (43%) and establishment of forages reserves (33%) (Technoserve, 2019).

In 2011, the Mainstreaming Sustainable Cattle Ranching Project defined a series of Good Livestock Practices that wanted to reduce the environmental impact of livestock due to agrochemicals contamination and increase rural labour welfare as well as cattle welfare (Uribe et al., 2011). The final objective of the Good Livestock Practices initiative was to increase livestock feed, increase carrying capacity and productivity, reduce production costs, increase water and soil quality and contribute to natural resources sustainable use and conservation (Rico, 2017). Since 2011, the national government has been working on 4 key policy areas: a) Nationally Appropriate Mitigation Actions, that includes sustainable cattle ranching as part of the agricultural sector proposals,

Silvo-pastoral initiatives exist in Colombia and aim to promote productivity through conservation and ecological macroeconomic strategies.

38) This is the main approach that the National Development Plan 2018-2022 adopt to implement sustainability or green growth approaches.
39) The five working regions and departments were: Cesar river valley (Cesar and Guajira), low Magdalena river (Atlántico and Bolivar), Boyacá and Santander, Orinoco grasslands foothills (Meta) and coffee growing zone ecoregion (Quindío, Risaralda, Caldas, Tolima and Valle del Cauca).

to reduce GHG emissions as well as to increase carbon stocks through agroecosystems; b) the implementation of sustainable cattle ranching as part of the Colombian Strategy for a Low Carbon Development; c) the REDD+ program in Colombia established a national registry of activities that reduce GHG emissions, in order to access compensation funds; d) Payment for ecosystems services for preserved forests and for reforestation/restoration, as a result of the development of article 111 of law 99/1993 and subsequent decrees (Díaz and Burkart, 2017).

In 2018, the Colombian Federation of Cattle Ranchers adopted a sectoral plan called "Colombian livestock. Roadmap 2018-2022" (FEDEGAN, 2018). In this document, the Colombian Federation of Cattle Ranchers summarized their goals for implementing SPS and a sustainable cattle ranching system that were: a) training, technical assistance, and knowledge transfer on sustainable cattle ranching production; b) fundraising with external organizations like regional governments or the petroleum royalties fund; c) generate a credit line with second tier Colombian bank for the agricultural sector with interest conditions according to the evolution of this business. Also, they proposed that, in order to establish environmental sustainability and a competitiveness strategy, biodiversity offsets should finance the implementation of SPS and agroforestry systems. These resources can help to protect water resources and biodiversity, riparian forests reforestation, fresh water environments protection, reforestation of water catchment areas, promote water and soil management.

Another important forum is the Colombian Roundtable on Sustainable Cattle Ranching. The need for a roundtable emerged as a result of a workshop held during 2013, to develop a National Policy on Sustainable Agro Climatic Livestock, led by the Ministry of Agriculture and the German Cooperation Agency, GIZ. In 2014 a working group was established to define the objectives and a first draft of the statutes. In 2015 the general guidelines and statutes were signed. Work plans were defined for 2016 and 2017 (Mesa Ganadería Sostenible Colombia, 2017). The objective of the Colombian Roundtable on Sustainable Cattle Ranching is to develop public policy on sustainable cattle ranching, following the development of a World Roundtable. Nearly 30 institutions participate, including the Colombian Federation of Cattle ranchers, the World Bank, the International Centre for Tropical Agriculture, representatives of beef production chain and milk National Councils, Agrosavia, Finagro, CIPAV, and WWF, among others. This initiative is supported by the National Planning Department, the Ministry of Agriculture and the Ministry of Environment in order to develop incentives that promote sustainable livestock production (Contexto Ganadero, 2017).

One of the most recent milestones for the livestock sector in Colombia is the Zero Deforestation Agreement for beef and milk, signed by the Colombian Federation of Cattle ranchers in October 2019[40]. This effort is in line with the Colombian Strategy for a Low Carbon Development and is also part of the goals of the National Development Plan (2018-2022) to sign zero deforestation agreements with 5 productive sectors (MADS, 2019).

Barriers to implementation

Even though the promotion of SPS might yield several social, economic and environmental benefits, the adoption of these production systems has faced significant implementation barriers in Colombia. A study by Calle et al. (2009) identified the main perceived barriers to SPS adoption in Quindío, Colombia. First, smallholder farmers often have low investment capacity, and the adoption of SPS presents high initial fixed costs[41] in terms of both financial and time investments, coupled with delayed returns (typically several years after implementation). Second, the adoption of SPS is perceived as risky due to the lack of the skilled workers, the information and the technology required to establish the new systems and manage them. Finally, social and cultural factors are considered as additional barriers that can be exacerbated when SPS is not implemented in all the farms within the same region and could, therefore, lead to conflicts between adopters and non-adopters in the farming community. Finally, farmers may bealso be concerned additionally about the unavailability of high-quality planting material to establish the tree cover (Calle et al., 2009).

The following table summarises some of the most critical economic, technical, environmental and sociocultural advantages and disadvantages associated with SPS and therefore is suggestive of the winners and losers from the policy switch.

Multiple types of SPS has been already identified in Colombia. Mahecha (2003) reports

- silvo-pastoral production in integration with natural forests,
- forest plantations for wood,
- orchards,
- trees for industrial purposes,
- plantations of fruit trees,
- meadows with trees and/or fodder shrubs in the meadows,
- mixed systems with trees or shrubs multipurpose for cutting,
- live fences,
- grazing in fodder banks of perennial woods.

40) The agreement is available at: https://www.minambiente.gov.co/images/BosquesBiodiversidadyServiciosEcosistemicos/pdf/Acuerdo_cero_deforestacion/Acuerdo_sector_Carne_Cero_Deforestacion.pdf

41) MSCRP calculated that implementation cost for non-intensive SPS (dispersed trees and live fences) are approximately 2 million COP (576 USD) per hectare, while intensive SPS are between 4 and 5 million COP (1,180 to 1497 USD) per hectare (Technoserve, 2019).

	ADVANTAGES	DISADVANTAGES
Economic	Combination of the production of goods over different time horizons More attractive returns than pure livestock production systems	Higher initial investments when compared to beef production
Technical and productive	Increased animal welfare and productivity provided by shade Increased moisture retention and grass quality	Increased complexity when compared to monocultures Lower production volumes of forest and animal products when combined and in comparison to traditional systems Competition between trees and grass Cattle might cause damage to trees
Environmental	Reduced carbon emissions compared to pure livestock systems Cattle provide weed and fire control, reducing costs for forestry protection Erosion control and increased watershed protection compared to livestock and sometimes pure plantations	
Social and cultural	The combined system provides more employment alternatives when compared to beef production systems	

Table 5. *Advantages and disadvantages of adopting silvo-pastoral systems*
Source: adapted from Braun et al., 2016

The costs for establishing SPS vary markedly with geographical location and the intended vegetation cover (types of trees and/or shrubs). Mahecha (2003) reports set-up cost of more than USD 1,100 (adjusted to USD2020) in the Cauca region of Colombia, of which more than half are necessary for transporting and planting of the trees.

Productivity and profitability in SPS
Since set-up costs are considered as one of the main barriers to adopting SPS, it is essential to identify strategies for scaling-up these alternative production systems in Colombia. One first important step in this direction is to gauge the economic impact of the introduction of SPS on the productivity and, more importantly, the profitability of cattle ranching in (the different regions of) Colombia. At the farm level, the prospects for SPS adoption will be influenced by a number of factors including any expected changes to the efficiency of the farming activity and the profitability of the business. Tools from productivity analysis are optimally placed to inform this discussion as they allow an assessment of the relative productivity and efficiency of firms adopting different management systems. Broadly speaking `efficiency' may be understood as the ability of the farm to produce in such a way as to achieve the maximum possible output given its input choice and the available technology. A farm is considered to be technically efficient (TE) when it is producing the maximum output (e.g. milk, meat, dairy products) from the minimum quantity of inputs (e.g. land, labour, capital, technology -- e.g. Kumbhakar et al., 2015)[42], It is worth pointing out, however, that farmers may well be technically efficient and still cause significant detrimental impacts on the natural environment. To achieve more sustainable farming management practices, it is necessary to consider farming performance in terms of the so-called environmental efficiency (EE) or 'eco-efficiency'. Eco-efficient agents produce the maximum output possible while generating the minimum environmental impacts; that is, they create value while decreasing the environmental impact (Huppes and Ishikawa, 2005).

An extensive body of literature has assessed the TE of crop production (see the meta-analysis developed by Thiam et al., 2001); dairy farms (Angon et al., 2013; Huang and Durón-Benítez, 2014; Kavoi et al., 2010; Ortega et al., 2007; Shortall and Barnes, 2013; Wubeneh, 2006); and beef farms (Gatti et al., 2015; Isyanto et al., 2013; Mlote, 2014; Nwigwe et al., 2016) in developing countries.

However, to our knowledge, no previous research has explored the adoption of silvo-pastoral systems from a technical and environmental efficiency standpoint. Nevertheless, limits exist on the applicability of this method that rely on detailed farmers' information for a significant sample of adopters and non-adopters.

Costs-benefits analysis and ecosystem services

There is extensive research investigating the financial benefits of implementing SPS as an alternative to the traditional livestock farming systems (Estrada Lopez, 2017; Gobbi and Casasola, 2003; González, 2013; Husak and Grado, 2002), the majority of the studies have focused on assessing the economic benefits associated with the increase in productivity. A smaller body of research has focused on assessing the monetary benefits associated with the social, environmental and economic changes derived from this policy (Braun et al., 2016; Pagiola et al., 2007; Rade et al., 2017).

There seems to be a consensus in the literature indicating that the adoption of SPS in Latin American countries is financially profitable. For instance, the study by Estrada Lopez (2017) estimated that the net benefits of an SPS production

42) An alternative, but substantially equivalent interpretation, of efficiency is the input-orientated one, whereby the benchmarking is performed in terms of the amount of inputs necessary to produce a given level of output.

unit in Michoacán, Mexico are approximately MXN 159,842.00, and observed a recovery of capital invested after six years of operation. A similar study, Rade et al. (2017), studied the financial viability of using silvo-pastoral systems in Manabi (Ecuador) for biofuel production and found a Net Present Value (NPV) of USD 404.11 when using live fences with Piñón (Jatropha curcas). The research of Gobbi and Casasola (2003) also estimated an incremental net present value of US$ 1,613[43] and an internal rate of return of 20% when investing in silvo-pastoral systems in Esparza, Costa Rica. In addition to this, their analysis indicated that PES schemes could generate a total income of USD 3,369 (without discounting during four years), which represents more than half of the investment associated with the costs of establishing this system in Esparza farms.

After two decades of pioneering SPS activities in Colombia the alternative cattle ranching system struggles to thrive and there is a need to assess the full spectrum of cost and benefits associated with the adoption of this production system by farmers.

43) Expense categories: Supplements, Animal health, Labor, Field inputs

Development and use of forage resources in sustainable systems of bovine production for Cauca department.

Photo: ©2018CIAT

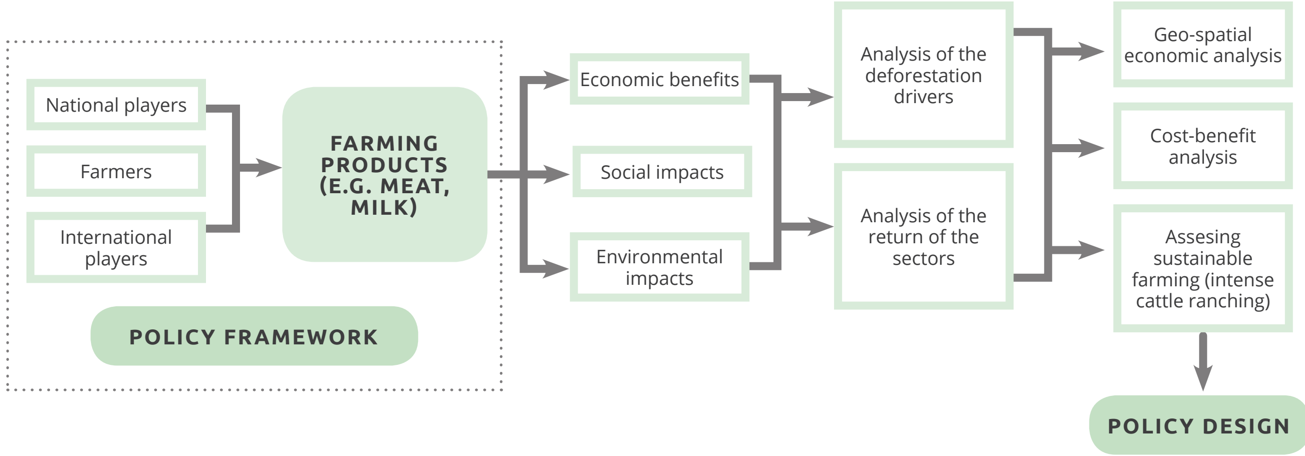


Figure 19. *Visioning and planning for sustainable farming opportunities.*

Research objectives

Against the background outlined above, the objective of our research activity is to contribute in broad terms to the Colombian debate on the transition to sustainable cattle ranching. Our first goal is to inform policy making by highlighting the costs and the benefits of the shift from extensive cattle ranching to intensive cattle ranching within the context of silvo-pastoral systems. We aim to do this with a proper appreciation of the importance of effectively accounting for the environmental impacts of cattle ranching. Our second strand of activity involves an evaluation of importance of ecosystem services for cattle ranching. This research will allow us to identify an appropriate level of subsidies to farmers who engage in sustainable farming. The final strand of this research brings all these elements together to simulate the impact of different policy scenarios on the rate of deforestation in Caquetá. Our goal is to present a viable alternative to deforestation based on a payment for ecosystem services scheme to reduce the economic advantage of deforestation over conservation (Fig. 19).

Methods and techniques

Our work builds on methods of extended cost benefit analysis to evaluate the contribution of the different economic, social and environmental factors to the economic valuation of the switch to silvo-pastoral systems. We will also deploy methods of productivity analysis, such as stochastic frontier estimation of output distance functions, to estimate the value of the contribution of eco-system services to the production of marketed outputs of cattle ranching, such as meat and milk, for example. Finally, we will use geo-referenced data within a Geographic Information Systems set-up, to gauge the potential differential impact of subsidies to conservation in the form of payment of eco-system services schemes, most likely in Caquetá.

References

Anato, 2018. Resultado Encuesta de Temporada de Fin de Año 2017.

Anderson L. G., Rocliffe S., Haddaway N.R., Dunn A.M., 2015. The Role of Tourism and Recreation in the Spread of Non-Native Species: A Systematic Review and Meta-Analysis. PLoS ONE 10(10): 0140833.

Anglaaere, L. C., Cobbina, J., Sinclair, F. L., & McDonald, M. A., 2011. The effect of land use systems on tree diversity: farmer preference and species composition of cocoa-based agroecosystems in Ghana. Agroforestry systems, 81(3), 249-265.

Angon, E., Garcia, A., Perea, J., Acero, R., Toro-Mujica, P., Pacheco, H., Gonzalez, A., 2013. Technical efficiency and viability of grazing dairy cattle systems in La Pampa, Argentine. Agrociencia 47, 443–456.

Araujo, Q.R. De, Gattward, J.N., Almoosawi, S., Parada Costa Silva, M. das G.C., Dantas, P.A.D.S., Araujo Júnior, Q.R. De, 2016. Cocoa and Human Health: From Head to Foot—A Review. Crit. Rev. Food Sci. Nutr. 56, 1–12. doi:10.1080/10408398.2012.657921.

Asare R., Afari-Sefa V., Muilerman S., 2018. Access to improved hybrid seeds in Ghana: implications for establishment and rehabilitation of cocoa farms. Experimental Agriculture, https://doi.org/10.1017/S0014479716000247.

Asare, R., Afari-Sefa, V., Osei-Owusu, Y., Pabi, O., 2014. Cocoa agroforestry for increasing forest connectivity in a fragmented landscape in Ghana. Agrofor. Syst. 88, 1143–1156. doi:10.1007/s10457-014-9688-3.

Avia Export, Tourism Leisure & Sports, & Europraxis, 2013. Plan de Negocio de Turismo de Naturaleza de Colombia Contenido. Presentación Final. Bogotá. Retrieved from https://www.colombiaproductiva.com/CMSPages/GetFile.aspx?guid=2ef226c3-5cb5-410a-b081-ad762c9f4e17

Badrie, N., Bekele, F., Sikora, E., Sikora, M., 2015. Cocoa Agronomy, Quality, Nutritional, and Health Aspects. Crit. Rev. Food Sci. Nutr. doi:10.1080/10408398.2012.669428.

Baptiste, B., Pinedo-Vasquez, M., Gutierrez-Velez, V.H., Andrade, G.I., Vieira, P., Estupiñán-Suárez, L.M., Londoño, M.C., Laurance, W., Lee, T.M., 2017. Greening peace in Colombia. Naure Ecology and Evolution, 1.

Bateman P.W., Fleming P.A., 2017. Are negative effects of tourist activities on wildlife over-reported? A review of assessment methods and empirical results. Biological Conservation, 211:10-19.

Bisseleua, D.H.B., Begoude, D., Tonnang, H., Vidal, S., 2017. Ant-mediated ecosystem services and disservices on marketable yield in cocoa agroforestry systems. Agric. Ecosyst. Environ. 247, 409–417. doi:10.1016/j.agee.2017.07.004.

Braun, A., van Dijk, S., Grulke, M., 2016. Upscaling Silvo-pastoral Systems, IDB Monograph 461.

Bravo, D., Pardo-Díaz, S., Benavides-Erazo, J., Rengifo-Estrada, G., Braissant, O., Leon-Moreno, C., 2018. Cadmium and cadmium-tolerant soil bacteria in cacao crops from northeastern Colombia. J. Appl. Microbiol. 124, 1175–1194. doi:10.1111/jam.13698.

CacaoNet, 2012. (www.cacaonet.org). Securing Our Future: why cocoa diversity Matters. Presentation at the World Cocoa conference 2012, Abidjan, Cote d'Ivoir.

Calle, A., Montagnini, F., Zuluaga, A., 2009. Farmer's perceptions of silvo-pastoral system promotion in Quindío, Colombia. Bois forêts des Trop.

Calle, Z., Murgueitio, E., Chará, J., Molina, C.H., Zuluaga, A.F., Calle, A., 2013. A Strategy for Scaling-Up Intensive Silvo-pastoral Systems in Colombia. J. Sustain. For. 32, 677–693. doi:10.1080/10549811.2013.817338.

Calle-rendón, B.R., Moreno, F., Hilário, R.R., 2018. Vulnerability of mammals to land-use changes in Colombia' s post-conflict era Vulnerability of mammals to land-use changes in Colombia ' s post-conflict era. Nature Conservation, 29, 72-92.

Carsan, S., Stroebel, A., Dawson, I., Kindt, R., Mbow, C., Mowo, J., & Jamnadass, R., 2014. Can agroforestry option values improve the functioning of drivers of agricultural intensification in Africa?. Current Opinion in Environmental Sustainability, 6, 35-40.

Carvajal Valero, K., Gonzalez, G.D., 2016. Marca Región Para El Turismo De Naturaleza En Colombia: Estrategias De Implementación. Bogotá D.C.

Ceballos-Lascuráin, H., 1996. Tourism, ecotourism, and protected areas. IUCN publication.

Cerda R., Deheuvels O., Calvache D., Niehaus L., Saenz Y., Kent J., Vilchez S., Villota A., Martinez C., Somarriba E.,2014. Contribution of cocoa agroforestry systems to family income and domestic consumption: looking toward intensification. Agroforest Systemt (2014) 88:957–981.

Chan, K. M. A., Balvanera, P., Benessaiah, K., Chapman, M., Díaz, S., Gómez-Baggethun, E., ... Turner, N., 2016. Opinion: Why protect nature? Rethinking values and the environment. Proceedings of the National Academy of Sciences, 113(6), 1462–1465.

Chappell, M.J., LaValle, L.A., 2011. Food security and biodiversity: Can we have both? An agroecological analysis. Agric. Human Values. doi:10.1007/s10460-009-9251-4.

Chará, J.D., Murgueitio, E., Zuluaga, A., Giraldo, C., 2011. Ganadería colombiana sostenible. Cali.

Chaux, M.A.., Pérez, M.A., 2017. ¿Nuevos caminos para los cacaos especiales de Colombia? Una experiencia desde el proyecto Coexca 2012 - 2017. Bogotá D.C.

Chen, S. and M. Ravallion, 2006. The Developing World Is Poorer Than We Thought, But No Less Successful in the Fight against Poverty, World Bank Policy Research Working Paper 4703

Clemens, S., Aarts, M.G.M., Thomine, S., Verbruggen, N., 2013. Plant science: The key to preventing slow cadmium poisoning. Trends Plant Sci. 18, 92–99. doi:10.1016/j.tplants.2012.08.003.

Cocoa Barometer 2018. Fountain, A.C & Hütz-Adams, F. (2018): Cocoa Barometer 2018. [WWW Document]. URL https://www.voicenetwork.eu/wp-content/uploads/2019/08/Cocoabarometer2018_web4.pdf (accessed 17.06.20).

Contexto Ganadero, 2017. ¿En qué consiste la Mesa Nacional de Ganadería Sostenible? Retrieved March 6, 2020, from https://www.contextoganadero.

com/ganaderia-sostenible/en-que-consiste-la-mesa-nacional-de-ganaderia-sostenible.

Contreras Pedraza, C.A., 2017. Análisis de la cadena de valor del cacao en Colombia: generación de estrategias tecnológicas en operaciones de cosecha y poscosecha, organizativas, de capacidad instalada y de mercado. Univ. Nac. Colomb. Fac. Ing. Universidad Nacional de Colombia.

Coria J. Calfucura E., 2012. Ecotourism and the development of indigenous communities: The good, the bad, and the ugly. Ecological Economics 73, 47–55.

Daghela Bisseleua, H.B., Fotio, D., Yede, Missoup, A.D., Vidal, S., 2013. Shade Tree Diversity, Cocoa Pest Damage, Yield Compensating Inputs and Farmers' Net Returns in West Africa. PLoS One 8. doi:10.1371/journal.pone.0056115.

Das M., Chatterjee B., 2015. Ecotourism: a panacea or a predicament? Tourism Managemen Perspective, 14, 3-16.

de Oliveira Santos G.E., 2015. Latin American Economy and Tourism, In eds. Panasso Netto A., Godoi Trigo L.G., Toursim in Latin America, Springer New York, DOI 10.1007/978-3-319-05735-4.

Deheuvels, O., Avelino, J., Somarriba, E., Malezieux, E., 2012. Vegetation structure and productivity in cocoa-based agroforestry systems in Talamanca, Costa Rica. Agric. Ecosyst. Environ. 149, 181–188. doi:10.1016/j.agee.2011.03.003.

DANE, Departamento Administrativo Nacional de Estadística, 2014. Censo Nacional Agropecuario.

DANE, Departamento Administrativo Nacional de Estadística, 2016a. Encuesta de Gasto en Turismo Interno - EGIT [WWW Document]. URL https://www.dane.gov.co/index.php/estadisticas-por-tema/servicios/turismo/encuesta-de-gasto-en-turismo-interno-egit (accessed 2.5.19).

DANE, Departamento Administrativo Nacional de Estadística, 2016b. Encuesta Nacional Agropecuaria - ENA [WWW Document]. URL https://www.dane.gov.co/index.php/estadisticas-portema/agropecuario/encuestanacional-agropecuaria-ena.

Departamento Nacional de Planeación, 2019. Plan Nacional de Desarrollo 2018-2022. Pacto por Colombia, pacto por la equidad. Tomo I. Bogotá D.C. Retrieved from https://colaboracion.dnp.gov.co/CDT/Prensa/PND-Pacto-por-Colombia-pacto-por-la-equidad-2018-2022.pdf.

Di Minin, E., Fraser, I., Slotow, R., Macmillan, D.C., 2013. Understanding heterogeneous preference of tourists for big game species: Implications for conservation and management. Anim. Conserv. 16, 249–258. doi:10.1111/j.1469-1795.2012.00595.x.

Díaz, M. F., & Burkart, S., 2017. Marco legal de la cadena de valor de la carne en Colombia. Bogotá, Colombia. Retrieved from https://cgspace.cgiar.org/handle/10568/83512

Díaz, R., Mora, R., Romero, J., 2013. Ecoturismo: diagnóstico y propuesta estratégica para la oferta de destinos ecoturísticos en Colombia por parte de las agencias de turismo localizadas en Bogotá , D.C. Cuad. Latinoam. Adm. 9, 7–28.

Díaz, S., Pascual, U., Stenseke, M., Martín-López, B., Watson, R. T., Molnár, Z., ... Shirayama, Y., 2018. Assessing nature's contributions to people. Science (New York, N.Y.), 359(6373), 270–272.

DNP-Departmento Nacional de Planeacion, 2018. Reporte Nacional Voluntario Colombia, Gobierno de Colombia.

Doiron S, Weissenberger S., 2014. Sustainable dive tourism: Social and environmental impacts—the case of Roatan, Honduras. Tourism Management Perspectives. 10: 19–26.

Donald, P. F., 2014. Biodiversity impacts of some agricultural commodity production systems. Conservation biology, 18(1), 17-38.

Doney S.C., Ruckelshaus, M., Duffy J.E., Barry J.P., Chan F., English C.A., Galindo H., Grebmeier J., Anne B. Hollowed, Nancy Knowlton, Jeffrey Polovina, Nancy N. Rabalais, William J. Sydeman, and Lynne D. Talley, 2012. Climate change impacts on marine ecosystems, Annual Review of Marine Science, 4, 11–37.

Drupp, M. A., Meya, J. N., Baumgärtner, S., & Quaas, M. F., 2018. Economic Inequality and the Value of Nature. Ecological Economics, 150, 340–345.

Estrada Lopez, I., 2017. Evaluación de Estrategias de Alimentaciónd en Unidades de Producción de Ganado Bovino Doble Propósito Bajo un Sistema Silvopastoril. Universidad Autónoma Del Estado de México.

FEDEGAN, 2018. Ganadería Colombiana. Hoja de ruta 2018-2020. Bogotá D.C., Colombia: Federación Colombiana de Ganaderos, FEDEGAN. Retrieved from http://static.fedegan.org.co.s3.amazonaws.com/publicaciones/Hoja_de_ruta_Fedegan.pdf

Fisher, B., & Turner, R. K., 2008. Ecosystem services: classification for valuation. Biological Conservation, 1, 8–10.

Fisher, B., Turner, K., Zylstra, M., Brouwer, R., de Groot, R., Farber, S., ... Balmford, A., 2008. Ecosystem services and economic theory: integration for policy-relevant research. Ecological Applications: A Publication of the Ecological Society of America, 18(8), 2050–67.

Forero-Medina, G., Joppa, L., 2010. Representation of global and national conservation priorities by Colombia's protected area network. PLoS One 5, 1–11. doi:10.1371/journal.pone.0013210.

Fundacion CIPAV, 2018. Mainstreaming Biodiversity in Sustainable Cattle Ranching (Ganaderia Colombiana Sostenible) [WWW Document]. URL http://www.cipav.org.co/noticias/noticias-n4.html (accessed 11.21.18).

García-Herrero L., De Menna F., Vittuari M.,2019. Sustainability concerns and practices in the chocolate life cycle: Integrating consumers' perceptions and experts' knowledge. Sustainable Production and Consumption 20 (2019) 117–127.

Gatti, N., Lema, D., Brescia, V., 2015. A meta-frontier approach to measuring technical efficiency and technology gaps in beef cattle production in Argentina. Agric. an Interconnected World. doi:211647.

Giraldo, C., Escobar, F., Chará, J.D., Calle, Z., 2011. The adoption of silvo-pastoral systems promotes the recovery of ecological processes regulated by dung beetles in the Colombian Andes. Insect Conserv. Divers. doi:10.1111/j.1752-4598.2010.00112.x.

Gobbi, J.A., Casasola, F., 2003. Comportamiento financiero de la inversión en sistemas silvopastoriles en fincas ganaderas de Esparza, Costa Rica. Agroforestería en las Américas 10, 52–60.

González, J.M., 2013. Costos y beneficios de un sistema silvopastoril intensivo (sspi), con base en Leucaena leucocephala (Estudio de caso en el municipio de Tepalcatepec, Michoacán, México). Av. en Investig. Agropecu. 17, 36–50.

Goodwin, H.., Leader-Williams, N., 2000. Tourism and protected areas–distorting conservation priorities towards charismatic megafauna. Priorities Conserv. Mamm. Divers. has panda had its day.

Gramlich, A., Tandy, S., Andres, C., Chincheros, J., Armengot, L., Schneider, M., Schulin, R., 2016. Cadmium uptake by cocoa trees in agroforestry and monoculture systems under conventional and organic management. Sci. Total Environ. doi:10.1016/j.scitotenv.2016.12.014.

Groeneveld, J.H., Tscharntke, T., Moser, G., Clough, Y., 2010. Experimental evidence for stronger cacao yield limitation by pollination than by plant resources. Perspect. Plant Ecol. Evol. Syst. doi:10.1016/j.ppees.2010.02.005.

Gumucio, M., Mora Benard, T., Clavijo, M.A., Hernández, M., Tafur, M.C., Twyman, J., 2015. Silvo-pastoral Systems in Latin America: Mitigation Opportunities for Men and Women Livestock Producers. Copenhagen.

Hargrove C., 1992. Weak anthropocentrism intrinsic value. The Monist, 75:183-207.

Hausmann, A., Slotow, R., Fraser, I., Di Minin, E., 2017. Ecotourism marketing alternative to charismatic megafauna can also support biodiversity conservation. Anim. Conserv. 20, 91–100. doi:10.1111/acv.12292.

Huang, W.-C., Durón-Benítez, Á.A., 2014. Farm technical efficiency under the seasonal milk production of the dual-purpose cattle system in El Salvador. J. Agric. Sci. Technol. A 4, 266–275.

Huppes, G., Ishikawa, M., 2005. A framework for quantified eco-efficiency analysis, in: Journal of Industrial Ecology. doi: 10.1162/108819805775247882.

Husak, A.L., Grado, S.C., 2002. Monetary and wildlife benefits in a silvo-pastoral system. South J Appl 26, 159–164. doi:10.1016/S0257-8972(09)90008-1.

IAvH, 2017. Biodiversidad colombiana: números para tener en cuenta [WWW Document]. September. URL http://www.humboldt.org.co/es/boletines-y-comunicados/item/1087-biodiversidad-colombiana-numero-tener-en-cuenta (accessed 11.14.18).

International Cocoa Organization. (n.d.). Retrieved September 18, 2020, from https://www.icco.org

ICOGe, https://sta.uwi.edu/cru/international-cocoa-genebank

Instituto colombiano agropecuario, 2012. Manejo fitosanitario del cultivo de cacao (*Theobroma cacao* L.): Medidas para la temporada invernal. Bogotá D.C. Colombia.

Instituto de Hidrología Meteorología y Estudios Ambientales (IDEAM), 2018. Resultados monitoreo de la deforestación 2018. Bogotá. Retrieved from http://www.ideam.gov.co/documents/24277/91213793/Actualizacion_cifras2018FINALDEFORESTACION.pdf/80b719d7-1bf6-4858-8fd3-b5ce192a2fdc.

Isyanto, A.Y., Semaoen, M.I., Hanani, N., 2013. Measurement of Farm Level Efficiency of Beef Cattle Fattening in West Java Province, Indonesia. J. Econ. Sustain. Dev.

Järup, L., Åkesson, A., 2009. Current status of cadmium as an environmental health problem. Toxicol. Appl. Pharmacol. doi:10.1016/j.taap.2009.04.020.

Jiménez-Pinedo, C., Domínguez-García, C., Pardo, M.A., Trujillo, F., Ávila, J.M., Palacios, D.M., 2011. Cetacean occurrence in the Tayrona National Park, a marine protected area in the Colombian Caribbean. Lat. Am. J. Aquat. Mamm. 9, 154–159.

Kavoi, M.M., Hoag, D.L., Pritchett, J., 2010. Measurement of economic efficiency for smallholder dairy cattle in the marginal zones of Kenya. Agric. Econ. 2, 122–137. doi: 10.1080/03031851003798603.

Kenter, J. O., 2018. IPBES: Don't throw out the baby whilst keeping the bathwater; Put people's values central, not nature's contributions. Ecosystem Services, 33, 40–43. http://doi.org/10.1016/J.ECOSER.2018.08.002.

Kerley, G.I.H., Geach, B.G.S., Vial, C., 2003. Jumbos or bust: do tourists' perceptions lead to an under-appreciation of biodiversity? South African J. Wildl. Res.

Klein, A.M., Steffan-Dewenter, I., Tscharntke, T., 2006. Rain forest promotes trophic interactions and diversity of trap-nesting Hymenoptera in adjacent agroforestry. J. Anim. Ecol. doi:10.1111/j.1365-2656.2006.01042.x.

Kokalj, Ž., 2007. Turbulent political circumstances bear on Colombians in a perpetual circle of violence [Kolumbija - Primer pomena stabilnih politi{č}nih razmer]. Geogr. Obz.

Kongor, J. E. Hinneh M.,Van de Walle D., Ohene Afoakwa E., Boeckx P., Dewettinck K., 2016. Factors influencing quality variation in cocoa (Theobroma cacao) bean flavour profile - A review. Food Res. Int. doi:10.1016/j.foodres.2016.01.012.

Krüger, O., 2005. The role of ecotourism in conservation: Panacea or Pandora's box? Biodivers. Conserv. doi:10.1007/s10531-004-3917-4.

Kumbhakar, S.C., Wang, H.-J., Horncastle, A.P., 2015. A Practitioner's Guide to Stochastic Frontier Analysis Using Stata, A Practitioner's Guide to Stochastic Frontier Analysis Using Stata. Cambridge University Press. doi:10.1017/cbo9781139342070.

Lazaro-Touza L., Atkinson G., 2013. Nature, road or hospitals? An empirical evaluation of 'sustainable development preference'. Ecological Economics, 95: 63-72.Atkinson, G and Obst, C (2017) Prices for ecosystem accounting. Prepared as part of the work program of the World Bank WAVES project. Technical Report. https://www.wavespartnership.org/en/knowledge-center/prices-ecosystem-accounting.

Lerner, A. M., Zuluaga, A. F., Chará, J., Etter, A., Searchinger, T. 2017. Sustainable cattle ranching in practice: moving from theory to planning in Colombia's livestock sector. Environmental management, 60(2), 176-184.

Livingstone, D. S., Freeman, B., Motamayor, J.C., Schnell, R.J.; Royaert, S., ; Takrama, J., Meerow, A.W., and Kuhn, D.N., 2011.

Lopez-Angarita J., Moreno-Sanchez R., Maldonado J., Sanchez J., 2014. Evaluating Linked Social–Ecological Systems in Marine Protected Areas. Conservation Letters, 7(3),241-252.

MADS, 2018. Por el cual se modifica el Capítulo 8 del Título 9 de la Parte 2 del Libro 2 del Decreto 1076 de 2015. Decreto Único Reglamentario del Sector Ambiente y Desarrollo Sostenible, en lo relacionado con la reglamentación de los componentes generales del incen. Bogotá: Diario Oficial. Retrieved from http://es.presidencia.gov.co/normativa/normativa/DECRETO 1007 DEL 14 DE JUNIO DE 2018.pdf.

MADS, 2019. Minambiente y FEDEGAN firman Acuerdo Cero Deforestación para sector cárnico y de lácteos. Retrieved March 6, 2020, from https://www.minambiente.gov.co/index.php/noticias/4523-minambiente-y-fedegan-firman-acuerdo-cero-deforestacion-para-sector-carnico-y-de-lacteos.

MADS, 2020. Acuerdos cero deforestación. Retrieved March 6, 2020, from https://www.minambiente.gov.co/index.php/acuerdos-cero-deforestacion#documentos-de-interés.

Mahecha, L., 2003. Importancia de los sistemas silvopastoriles y principales limitaciones para su implementación en la ganadería colombiana. Conciencias Pecu.

Maldonado, J. H., del Pilar Moreno-Sánchez, R., Espinoza, S., Bruner, A., Garzón, N., & Myers, J. 2018. Peace is much more than doves: The economic benefits of bird-based tourism as a result of the peace treaty in Colombia. World Development, 106, 78-86.

Maldonado, J., Moreno-Sánchez, R., Espinoza, S., Bruner, A., Garzón, N., Myers, J., 2016. La paz es mucho más que palomas: beneficios económicos del acuerdo de paz en Colombia, a partir del turismo de observación de aves. Conserv. estratégica 1–9. doi:10.1145/2505515.2507827.

Martínez, J., Cajas, Y.S., León, J.D., Osorio, N.W., 2014. Silvo-pastoral systems enhance soil quality in grasslands of Colombia. Appl. Environ. Soil Sci. doi:10.1155/2014/359736.

McClenachan, L., Cooper, A.B., Carpenter, K.E., Dulvy, N.K., 2012. Extinction risk and bottlenecks in the conservation of charismatic marine species. Conserv.

Lett. 5, 73–80. doi:10.1111/j.1755-263X.2011.00206.x.

MCIT, 2010. Informe del Turismo en Colombia. Bogotá DC.

MCIT, 2012a. Linamientos de política para el desarrollo del turismo comunitario en Colombia. Bogotá: Ministerio de Comercio, Industria y Turismo. Retrieved from https://www.mincit.gov.co/CMSPages/GetFile.aspx?guid=58fc480a-7a27-4420-aac4-e72c8bcee437.

MCIT, 2012b. Política de turismo de naturaleza. Bogotá: Ministerio de Comercio, Industria y Turismo. Retrieved from https://www.mincit.gov.co/getattachment/minturismo/calidad-y-desarrollo-sostenible/politicas-del-sector-turismo/politica-de-turismo-de-naturaleza/politica-de-turismo-de-naturaleza/politica-de-turismo-de-naturaleza.pdf.aspx

MCIT, 2019. Ajuste cifra de visitantes extranjeros. Bogotá D.C. Retrieved from http://www.mincit.gov.co/getattachment/estudios-economicos/estadisticas-e-informes/informes-de-turismo/ajuste-cifra-de-visitantes-extranjeros/ajuste-cifra-visitantes-vf-pagina-web.pdf.aspx.

MCIT, MADS, 2003. Política para el Desarrollo del Ecoturismo. Colombia.

Medina, V. and Laliberte B., 2017. A review of research on the effects of drought and temperature stress and increased CO2 on *Theobroma cacao* L., and the role of genetic diversity to address climate change. Bioversity International, Rome, Italy.

Meier, B.P., Noll, S.W. and Molokwu, O.J., 2017. The sweet life: the effect of mindful chocolate consumption on mood. Appetite, 108, pp.21-27.

Mesa Ganadería Sostenible Colombia, 2017. VIII Foro Regional de Ganadería Sostenible. Pasto, Nariño. Retrieved from http://ganaderiacolombianasostenible.co/web/wp-content/uploads/2017/11/MESA-GANADERÍA-SOSTENIBLE-COLOMBIA-1.pdf.

Middendorp, R.S., Vanacker, V., Lambin, E.F., 2018. Impacts of shaded agroforestry management on carbon sequestration, biodiversity and farmers income in cocoa production landscapes. Landsc. Ecol. 33, 1953–1974. doi:10.1007/s10980-018-0714-0.

Millard E., 2011. Incorporating Agroforestry Approaches into Commodity Value Chains, Environmental Management (2011) 48:365–377.

Ministerio de Agricultura y Desarrollo Rural, 2018. MinAgricultura se une a iniciativa Cacao, Bosques y Paz [WWW Document]. 17 July. URL https://www.minagricultura.gov.co/noticias/Paginas/MinAgricultura-se-une-a-iniciativa-Cacao,-Bosques-y-Paz.aspx (accessed 12.6.18).

Ministerio de Agricultura y Desarrollo Rural, & Unidad de Planificación Rural Agropecuaria - MADR, 2018. Identificación general de la frontera agrícola en Colombia. Bogotá. Retrieved from https://www.minagricultura.gov.co/Normatividad/Projects_Documents/IDENTIFICACION GENERAL DE LA FRONTERA.pdf.

Ministerio de Justicia, 2003. El Desarrollo Alternativo. Bogotá, Colombia.

Mlote, N., 2014. Estimating technical efficiency of small scale beef cattle fattening in the lake zone in Tanzania. J. Dev. Agric. Econ. 5, 197–207. doi:10.5897/jdae12.0436.

Molina, C.H., Molina-Durán, C.H., Molina, E.J., Molina., J.P., 2008. Carne, leche ymejor ambiente en el sistema silvopastoril con Leucaena leucocephala, in: Murgueitio, E., Cuartas, C., Naranjo, J.F. (Eds.), Ganadería Del Futuro: Investigación Para El Desarrollo. Fundación CIPAV., Cali, Colombia, pp. 41–65.

Montagnini, F., Finney, C., 2011. Payments for environmental services in latin America as a tool for restoration and rural development. Ambio 40, 285–297. doi:10.1007/s13280-010-0114-4.

Mosquera, O., Buurman, P., Ramirez, B.L., Amezquita, M.C., 2012. Carbon stocks and dynamics under improved tropical pasture and silvo-pastoral systems in Colombian Amazonia. Geoderma 189–190, 81–86. doi:10.1016/j.geoderma.2012.04.022.

Murgueitio, E., Calle, Z., Uribe, F., Calle, A., Solorio, B., 2011. Native trees and shrubs for the productive rehabilitation of tropical cattle ranching lands. For. Ecol. Manage. 261, 1654–1663. doi:10.1016/j.foreco.2010.09.027.

Naidoo, R., Adamowicz, W.L., 2005. Biodiversity and nature-based tourism at forest reserves in Uganda. Environ. Dev. Econ. doi:10.1017/S1355770X0400186X. Retrieved September 18, 2020, from https://slideplayer.com/slide/5800310/

Norris, K., and Wade, A. (n.d.). Carbon, biodiversity and cocoa farming in Ghana. Centre for Agri-Environmental Research, The University of Reading. Retrieved September 18, 2020, from https://slideplayer.com/slide/5800310/

Nwigwe, C., Okoruwa, V., Adenegan, K., Olajide, A., 2016. Technical efficiency of beef cattle production technologies in Nigeria: a stochastic frontier analysis. African J. Agric. Res.

O'Neill, J., Holland, A., & Light, A., 2008. Environmental values. Routledge.

Obeng, E.A., Aguilar, F.X., 2015. Marginal effects on biodiversity, carbon sequestration and nutrient cycling of transitions from tropical forests to cacao farming systems, AGROFORESTRY SYSTEMS, 10.1007/s10457-014-9739-9.

Ocampo-Peñuela, N., Winton, R.S., 2017. Economic and Conservation Potential of Bird-Watching Tourism in Postconflict Colombia. Trop. Conserv. Sci. 10, 194008291773386. doi:10.1177/1940082917733862.

OEHHA, 2001. Proposition 65 Maximum Allowable Daily Level (MADL) for Reproductive Toxicity for Cadmium (Oral Route) Office of Environmental Health Hazard Assessment (OEHHA) Reproductive and Cancer Hazard Assessment Section [WWW Document].

Okello, M.M., Yerian, S., 2009. Tourist satisfaction in relation to attractions and implications for conservation in the protected areas of the Northern Circuit, Tanzania. J. Sustain. Tour. doi:10.1080/09669580902928450.

Ortega, L. E., R. Ward, and C. O. Andrew, 2007. Technical Efficiency of the Dual-Purpose Cattle System in Venezuela. Journal of Agricultural and Applied Economics, Southern Agricultural Economics Association, 39(3), 1-14.

Paciullo, D.S.C., de Castro, C.R.T., Gomide, C.A. de M., Maurício, R.M., Pires, M. de F.Á., Müller, M.D., Xavier, D.F., 2011. Performance of dairy heifers in a silvo-pastoral system. Livest. Sci. doi:10.1016/j.livsci.2011.05.012.

Padi, F.K., Ofori, A. Arthur, A., 2017. Genetic variation and combining abilities for vigour and yield in a recurrent selection programme for cacao, Journal of Agricultural Science, 10.1017/S0021859616000459.

Pagiola, S., Ramírez, E., Gobbi, J., de Haan, C., Ibrahim, M., Murgueitio, E., Ruíz, J.P., 2007. Paying for the environmental services of silvo-pastoral practices in Nicaragua. Ecol. Econ. 64, 374–385. doi:10.1016/j.ecolecon.2007.04.014.

Pineda-Guerrero, A., González-Maya, J.F., Pérez-Torres, J., 2015. Conservation value of forest fragments for medium-sized carnivores in a silvo-pastoral system in Colombia. Mammalia. doi:10.1515/mammalia-2013-0050.

Pratt M.L. 2010. Ojos imperiales. México: Fondo de Cultura Económica

PROEXPORT, 2012. Informe Turismo Extranjero en Colombia.

Rade, D.Y., Cañadas, A., Zambrano, C., Molina, C., Ormaza, A., Wehenkel, C., 2017. Viabilidad económica y financiera de sistemas silvopastoriles con Jatropha curcas L. en Manabí, Ecuador. Rev. MVZ Córdoba 22, 6241. doi:10.21897/rmvz.1129.

Ramirez, J.W.M., 2008. El ecoturismo en Colombia. Revista Teckne, 47(4).

Ramírez, M., Enríquez, M.L., 2003. Riqueza y diversidad de hormigas en sistemas silvopastoriles del Valle del Cauca, Colombia. Livest. Res. Rural Dev.

Red Nacional Cacaotera, 2016. Asociatividad e inclusión de cacaocultores en el desarrollo económico local. [WWW Document]. URL eoro.org.co/pdf/5-Asociatividad-como-eje-de-inclusion-Miguel- Vargas-Redcacaotera.pdf (accessed 2.4.17).

Restrepo, N., & Anton Clavé, S., 2019. Institutional Thickness and Regional Tourism Development: Lessons from Antioquia, Colombia. Sustainability, 11(9), 2568.

Rico, G., 2017. Colombia: ¿Existe y es viable la ganadería sostenible? Retrieved March 6, 2020, from https://es.mongabay.com/2017/12/colombia-existe-viable-la-ganaderia-sostenible/

Ríos, F., Ruiz, A., Lecaro, J., C., R., 2017. Estrategias país para la oferta de cacaos especiales -Políticas e iniciativas privadas exitosas en el Perú, Ecuador, Colombia y República Dominicana. Fundación Swisscontact Colombia. Bogotá D. C. 140 p. [WWW Document]. https://www.swisscontact.org/fileadmin/user_upload/COUNTRIES/Colombia/Documents/Content/Estrategias_Pais_Cacaos_Especiales.pdf (accessed 17.6.20).

Rivera, J.E., Chará, J., Barahona, R., 2016. Life Cycle Assessment For The Production Of Cattle Milk In An Intensive silvo-Pastoral System And A Conventional System In Colombia. Trop. Subtrop. Agroecosystems 19, 237 – 251.

Rivera, L.F., Armbrecht, I., Calle, Z., 2013. Silvo-pastoral systems and ant diversity conservation in a cattle-dominated landscape of the Colombian Andes. Agric. Ecosyst. Environ. 181, 188–194. doi:10.1016/j.agee.2013.09.011.

Rivera, L.F., Botero, M., Escobar, S., Armbrecht, I., 2008. Diversidad de Hormigas en sistemas ganaderos, in: Ganadería Del Futuro: Investigación Para El Desarrollo. pp. 227–267.

Roberts, M., Hanley, N., Cresswell, W., 2017. User fees across ecosystem boundaries: Are SCUBA divers willing to pay for terrestrial biodiversity conservation? J. Environ. Manage. doi:10.1016/j.jenvman.2017.05.070.

Saj, S., Jagoret, P., Etoa, L.E., Fonkeng, E.E., Tarla, J.N., Nieboukaho, J.D.E. and Sakouma, K.M., 2017. Lessons learned from the long-term analysis of cacao yield and stand structure in central Cameroonian agroforestry systems.

Sanchéz Matta, L., Amado Saavedra, GM, Criollo Campos, PJ Carvajal Salcedo, T., Roa Triana, J., Cuesta Peralta, A., Conde Pulgarín, A., Umaña Arboleda, A., Bernal, L., Barreto de Escovar, L., 2009. El Sauco (sambucus nigra) como alternativa silvopastoril en el manejo sostenible de praderas en el trópico alto colombiano. Colombia.

Satarug, S., Garrett, S.H., Sens, M.A., Sens, D.A., 2010. Cadmium, environmental exposure, and health outcomes. Environ. Health Perspect. doi:10.1289/ehp.0901234.

Schroth, G., Harvey, C.A., 2007. Biodiversity conservation in cocoa production landscapes: An overview. Biodivers. Conserv. 16, 2237–2244. doi:10.1007/s10531-007-9195-1.

Sekercioglu, C.H., 2002. Impacts of birdwatching on human and avian communities. Environ. Conserv. doi:10.1017/S0376892902000206.

Shortall, O.K., Barnes, A.P., 2013. Greenhouse gas emissions and the technical efficiency of dairy farmers. Ecol. Indic. 29, 478–488. doi:10.1016/j.ecolind.2013.01.022.

SITUR PCC, 2018. Resultados Encuesta Turismo Receptor Paisaje Cultural Cafetero (Pcc).

Somarriba, E., Cerda, R., Orozco, L., Cifuentes, M., Dávila, H., Espin, T., Mavisoy, H., Ávila, G., Alvarado, E., Poveda, V., Astorga, C., Say, E., Deheuvels, O., 2013. Carbon stocks and cocoa yields in agroforestry systems of Central America. Agric. Ecosyst. Environ. 173, 46–57. doi:10.1016/j.agee.2013.04.013.

Sousa, L.F., Maurício, R.M., Moreira, G.R., Gonçalves, L.C., Borges, I., Pereira, L.G.R., 2010. Nutritional evaluation of “Braquiarão” grass in association with “Aroeira” trees in a silvo-pastoral system. Agrofor. Syst. doi:10.1007/s10457-010-9297-8.

Squicciarini, M.P. and Swinnen, J. eds., 2016. The economics of chocolate. Oxford University Press.

Srinivasan, U. T., Carey, S. P., Hallstein, E., Higgins, P. A. T., Kerr, A. C., Koteen, L. E., … Norgaard, R. B., 2008. The debt of nations and the distribution of ecological impacts from human activities. Proceedings of the National Academy of Sciences of the United States of America, 105(5), 1768–73. http://doi.org/10.1073/pnas.0709562104.

Stronza, A.L., Hunt, C.A., Fitzgerald L.A., 2019. Ecotourism for Conservation? Annual Review of Environment and Resources. 44 (1), 229-253. doi: https: 10.1146/annurev-environ-101718-033046.

Suarez, A. V., Bolger, D.T., Case, T.J., 1998. Effects of fragmentation and invasion on native ant communities in coastal southern California. Ecology 79, 2041–2056. doi:10.1890/0012-9658(1998)079[2041:EOFAIO]2.0.CO;2.

T&L europraxis and Avia Export, 2012. Diagnóstico Turismo de Naturaleza en Colombia.

Tadu, Z., Djiéto-Lordon, C., Yede, Youbi, E.M., Aléné, C.D., Fomena, A., Babin, R., 2014. Ant mosaics in cocoa agroforestry systems of Southern Cameroon: influence of shade on the occurrence and spatial distribution of dominant ants. Agrofor. Syst. 88, 1067–1079. doi:10.1007/s10457-014-9676-7.

Technoserve, 2019. Study on the Implementation and Expansion of Silvopastoral Systems for Colombian Cattle Ranchers. Bogotá D.C. Retrieved from http://pubdocs.worldbank.org/en/503031575495352767/PPT-Business-Case-Colombia-Mainstreaming-Sustainable-Cattle-Ranching-Project-Study-on-the-implementation-and-expansion-of-silvopastoral-systems-for-Colombian-Cattle-Ranchers.pdf.

Thiam, A., Bravo-Ureta, B.E., Rivas, T.E., 2001. Technical efficiency in developing country agriculture: A meta-analysis. Agric. Econ. doi:10.1016/S0169-5150(01)00081-0.

Tilman, D., Reich, P.B., Isbell, F., 2012. Biodiversity impacts ecosystem productivity as much as resources, disturbance, or herbivory. Proc. Natl. Acad. Sci. doi:10.1073/pnas.1208240109.

Tisdell, C. and Wilson, C. 2012. Nature-Based Tourism and Conservation: New Economic Insights and Case Studies. Cheltenham, U.K. and Northampton, Massachusetts: Edward Elgar.

Toledo-Hernández, M., Wanger, T.C., Tscharntke, T., 2017. Neglected pollinators: Can enhanced pollination services improve cocoa yields? A review. Agric. Ecosyst. Environ. 247, 137–148. doi:10.1016/j.agee.2017.05.021.

Trujillo, J.C., Navas, E.J., Vargas, D.M., 2017. Valuing coral reef preservation in a caribbean marine protected area. Economic impact of scuba diving in corals of Rosario and San Bernardo national natural park, Colombia. Cuad. Desarro. Rural 14. doi:10.11144/Javeriana.cdr14-79.vcrp.

Turner R.K., 2016. The Balance Sheet approach. In Potschin et al., 2016. Eds Routledge Handbook of Ecosystem Services, Routledge, London.

Turner R. K., Toledo-Gallegos, V., Ferrini, S., Erazo J., and Di Maria, C., 2019. Colombia’s Natural Capital. Report. GROW Colombia Project Series. Earlham Institute, Norwich.

Turner, R. K., Toledo-Gallegos, V., Ferrini, S., Erazo, J., Di Maria, C., Valderrama, N. and Di Palma, F., 2020. Colombia’s Natural Capital. Report 1. GROW Colombia Project Series. GROW Colombia Project UKRI GCRF Grant BB/P028098/1. Norwich, UK.

Turner, R. K., 2007. Limits to CBA in UK and European environmental policy: retrospects and future prospects. Environmental and Resource Economics, 37(1), 253–269.

United Nations, 2018. The Sustainable Development Goals Report, United Nations Publications. doi:10.18356/3405d09f-en.

UNWTO, 2018. Tourism and the Sustainable Development Goals – Journey to 2030.

Uribe, F., Zuluaga, A., Valencia, L., Murgueitio, E., Ochoa, L., & CIPAV, 2011. Proyecto ganadería colombiana sostenible, Buenas practicas ganaderas.3. Manual. (F. Uribe, Ed.). Bogotá, Colombia.: GEF, BANCO MUNDIAL, FEDEGÁN, CIPAV, FONDO ACCION, TNC. Retrieved from http://www.cipav.org.co/pdf/3.Buenas.Practicas.Ganaderas.pdf.

USAID, United States Department of Agriculture Foreign Agricultural Service, Purdue University, International Center for Tropical Agriculture, 2017. An Analysis on the Supply Chain of Cacao in Colombia.

USESPN-OEE-MINCIT, 2018. Estadisticas Nacionales-Parques Nacionales Naturales.

Van Exel, N. Job, A., and de Graaf, Gjalt, 2015. Q methodology: A sneak preview.

Van Lange, P. A., Otten, W., De Bruin, E. M., and Joireman, J. A., 1997. Development of prosocial, individualistic, and competitive orientations: theory and preliminary evidence. Journal of Personality and Social Psychology, 73(4), 733–46.

van Wensem, J., 2015. Timely Scientific Opinions: overview of scientific evidence for chocolate health benefits. Integr. Environ. Assess. Manag. 11, 171–171. doi:10.1002/ieam.1671.

van Zanten, B. T., Van Berkel, D. B., Meentemeyer, R. K., Smith, J. W., Tieskens, K. F., & Verburg, P. H., 2016. Continental-scale quantification of landscape values using social media data. Proceedings of the National Academy of Sciences of the United States of America, 201614158.

Vatn, A., 2005. Rationality, institutions and environmental policy. Ecological Economics, 55(2), 203–217.

Vatn, A., & Bromley, D. W., 1994. Choices without Prices without Apologies. Journal of Environmental Economics and Management, 26(2), 129–148.

Veríssimo, D., Fraser, I., Groombridge, J., Bristol, R., MacMillan, D.C., 2009. Birds as tourism flagship species: A case study of tropical islands. Anim. Conserv. 12, 549–558.

World Bank, 2018. The World Bank Open Data – Colombia. Retrieved from https://data.worldbank.org/country/colombia.

World Bank, 2020. Mainstreaming Sustainable Cattle Ranching. Retrieved March 6, 2020, from https://projects.worldbank.org/en/projects-operations/project-detail/P104687

World Health Organization, 2010. Exposure to cadmium: a major public health concern. Prev. Dis. Through Heal. Environ. doi:10.1016/j.ecoenv.2011.12.007.

WTTC, 2017. Travel & Tourism Economic Impact 2017: Colombia. London.

Wubeneh, N., 2006. Technical Efficiency of Smallholder Dairy Farmers in the Central Ethiopian highlands. Int. Assoc. Agric. Econ. Conf. 16.

WWF-Colombia, 2017. Living Colombia: A megadiverse country facing the future 2017 Report. World Wildlife Fund. Cali, Colombia.

Zapetis, M.E., Samuelson, M.M., Botero-Acosta, N., Kuczaj, S.A., 2017. Evaluation of a Developing Ecotourism Industry: Whale Watching in the Gulf of Tribugá, Colombia. Int. J. Comp. Psychol. 30, 16.

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